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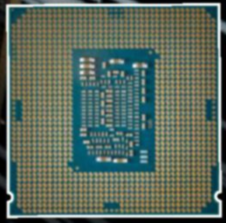

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Tuan Nguyen

A YEAR OF CHANGES

IN A FLURRY of announcements last year, Intel shook the desktop and mobile scene with a number of back to back CPU releases. It was the first time that the CPU giant veered off its normal Tick-Tock release schedule. Not only was it confusing to the market, but it became apparent its Skylake CPUs were a detour from the real destination: Kaby Lake.

The new CPU architecture brings with it a sea of changes, which include a brand new 200 Series chipset, higher clock speeds, improved integrated graphics, more PCIe lanes, and support for Intel's new Optane storage—you know, the really crazy fast storage Intel has been boasting about. Apparently, Optane is supposed to give current NVMe drives a run for their money.

Kaby Lake will bring us full-fledged into 2017, a year of more innovation and excitement for the industry. 2016 was the year for VR. But VR kind of showed up with a huge hurrah, and then the excitement fizzled. However, Microsoft recently made a huge announcement that would help catapult both the VR and AR industries forward. We're going to see faster everything, with lower price points than before, all in the name of change.

I'm all for change, especially on such a vibrant platform. Everything started pointing back toward the PC in 2016, and there's never been a better time to be out with the old and in with the new.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

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THE NEWS

Facebook Colludes in State Censorship

Just how far will the social media company go to break into new markets?

FACEBOOK is preparing for the Chinese market, and part of that preparation is the development of tools to enable the Chinese government to suppress unrest by ensuring that posts on certain subjects never appear. Facebook won't do the censorship itself, but it will supply the means for a third party to monitor feeds and decide what goes live.

Facebook has refused to confirm or deny the existence of such tools as yet; it's still an internal project. Their existence was leaked by employees, alarmed by the implications. The Electronic Frontier Foundation, the leading non-profit organization defending civil liberties, calls the project "extremely disturbing."

Facebook has made no secret of trying to get into China. Mark Zuckerberg has made many visits, met President Xi, and even started to learn Mandarin. The lure is obvious. The Internet is censored in China, and effectively, too. Any company that doesn't comply faces being blocked; censorship isn't optional. Actually, such tools were inevitable.

China loves the Internet, censored or not. Realistically, though, Facebook's chances of success there are pretty slim. A domestic Facebook-like app has already failed there. Renren claimed 160 million users at its stock launch, but quickly withered. The big thing is WeChat, largely used on smartphones; it has 846 million active users. Blocking foreign competition for so long has enabled domestic companies to become well established. Put simply, the Chinese state would prefer the big players on its home turf to be Chinese and under close control, and it has the power to make that so. Apple is a rare success, and that has drawn a backlash.

Meanwhile, at home, Facebook has faced calls to censor fake news stories, many of which circulated before the election, at one point gaining more coverage than the real ones. Initially, the company denied it had influenced the outcome of the election—"a pretty crazy idea," according to Zuckerberg. He may have a point: People tend to read and spread stories they already either agree or disagree with strongly. This was later followed by a more nuanced response. Facebook said it will employ third-party fact-checkers and stronger detection by algorithms in future.

> Meanwhile, at home, Facebook has faced calls to censor fake news stories.

This man has access to personal data on 1.8 billion people—do you trust him?

We may abhor censorship in theory, but it's remarkable how quickly it is called for when we don't like the results of unrestricted access. It is a slippery slope on a delicate balance. As Mr Zuckerberg commented, "we need to be careful not to discourage sharing of opinions or mistakenly restricting accurate content." However, it is still a big step from removing individual articles to allowing wholesale censorship on specific subjects under state control. The Chinese experiment is moving into darker waters.

An uncomfortable question here is how far is Facebook willing to compromise to get new business? Social media sites need to keep moving or they sink. Facebook has started to hit the limits on growth in mature markets; with 67 percent of adult Americans having access, there can't be much more room for growth here. To grow it must go abroad, where local laws, and state controls, can be very different.

In a recent press interview, Mark Zuckerberg was asked what checks and balances needed to exist for entities such as Facebook, as those checks and balances currently seemed to be Zuckerberg himself. The reply consisted largely of platitudes on connectivity and the power to share. It was particularly unconvincing stuff. There is a growing gap between accountability and responsibility that will need addressing at some point. **–CL**

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*External monitor must support HDMI input (If continuum-compatible accessory is not included, add: "Accessories sold seperately.") **App availability and experience varies by device and market. Office 365 subscription required for some features. 1Limited to select premium phones at launch. Feature and app availability and experience may vary by market and device. Windows Hello required specialized hardware, including fingerprint reader, illuminated IR sensor or other biometric sensors.

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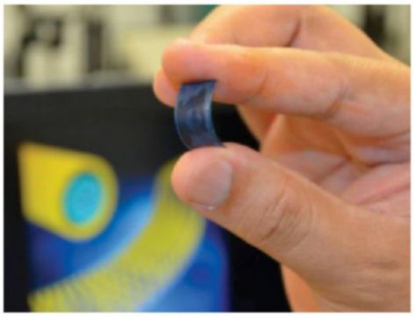

CHARGE YOUR PHONE IN SECONDS

Miniature supercapacitor battery prototype built

RESEARCHERS at the University of Central Florida have produced a prototype supercapacitor battery for small devices that can be charged in seconds, but potentially last all week. It can also be recharged 30,000 times without degrading.

Supercapacitors store energy electrostatically on the surface of a material. There are no chemical processes, which are slow and cause physical damage to the structure of the battery. A supercapacitor can charge and discharge extremely rapidly, because the only moving thing internally is the electrical charge.

Traditionally, supercapacitor tech has been held back by low energy density. To get a usable amount of power meant unfeasibly large capacitors, limiting previous applications to buses and trains. This is where the new generation of nanomaterials comes in, making it possible to build huge surface areas into a tiny film of material. The prototype contains millions of nanometer-thick coated wires to store the static charge.

Before we get too excited, this is still at the proof of concept phase, but building a working prototype looks encouraging. The Florida team is among many such groups working on new battery technologies, and many use nanotechnology in one form or another. A group based at MIT has developed a new form of anode built from carbon nanotubes, to boost the effectiveness of Lithium-ion batteries, which shows promise.

The world has been waiting for a replacement for chemical batteries for years; while everything has got more capable and faster, it has drained batteries all the more rapidly. If nanotechnology capacitors can be made commercially viable, waiting hours for your car or phone to charge will become a distant memory. **–CL**

APPLE BACKLASH

APPARENTLY WE DO WANT OTHER CONNECTORS

THE NEW MACBOOK PRO has USB-C ports, and that's it. Which means you'll need an adapter to plug just about every other piece of kit you have into it. And there are no adapters in the box. Cue much foaming and frothing online from some understandably annoyed customers. To calm things down, Apple has temporarily dropped the prices on its adapters, of which there are 17 different types. Price cuts range from around 25 to 50 percent. The basic USB-C to USB adapter drops from $19 to $9.

A statement from the company includes this nugget: "We recognize that many users, especially pros, rely on legacy connectors to get work done today." Legacy? You can't even connect a brand-new iPhone without an adapter. Apple has an enviable reputation for innovation, but this isn't the first time the company has tried to push things along a little too quickly for comfort. **–CL**

OLD-SCHOOL BUDGET OVERCLOCKING COULD BE BACK

New K-series i3 comes unlocked

intel
Core™ i3 K

REMEMBER THE CELERON 300A? It was cheap, unlocked, and capable of being absolutely thrashed. It meant you could buy cheap, play with the clock multiplier, and go hundreds of megahertz faster. And it was stable, too. It was basically the same silicon as the more expensive models, and just as capable. Then Intel starting locking its chips down, bar a few high-end specialities. However, it looks as though we could be in business again with the new Kaby Lake i3-7350K, multiplier unlocked out of the box. At stock it runs at 4.0GHz, with a 4.2GHz Turbo, and unlike the other new i3s, it also has Hyper-Threading enabled.

Early reports are very enthusiastic, with it out-gunning nearly all the previous generation of quad-core Core i5s and i7s. It means you can build a highly capable games machine on a budget, and get to tweak the best out of it. Early pricing has it going for $177. We predict it'll be rather popular. **–CL**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS	TRAGEDIES
VR HELPS HEAD TRANSPLANT The doctor planning a full head transplant next year is to use VR to prepare the patient for the experience of having a new body.	**RUSSIA BANS LINKEDIN** Russia demands all data on Russian citizens be held on Russian soil; this has caused LinkedIn to be banned.
UBER DRIVERS WIN APPEAL Drivers thrown off Uber with no explanation have won the right to appeal the decision—quite right, too.	**IPHONE FREEZE** A short MP4 video doing the rounds causes iPhones to freeze, requiring a hard reset; a corruption causes an infinite loop.
APPLE WILL FIX IT Apple has acknowledged the iPhone "touch disease" problem, and will now fix it for $149, and reimburse those who previously paid more.	**OFFICE DEPOT SCAM** It has been caught telling customers that factory-fresh PCs needed expensive fixes after using PC Health Check software.

Jarred Walton

TECH TALK

Bitcoins and Cryptocurrency

IF YOU HAVEN'T HEARD OF BITCOIN, don't feel bad—I've dabbled in bitcoin since 2011, and while some general awareness of it now exists, most people still don't really know what it is or why we need it, or if we should even want it. The brief synopsis goes something like this, and I'm intentionally skipping a lot of the complexity.

The core idea is to have a currency backed by the power of cryptography (i.e., math), rather than governments, gold, or another physical entity. Neal Stephenson's book *Cryptonomicon* contained an idea like this back in 1999, and in 2008, Satoshi Nakamoto introduced bitcoin to a cryptography mailing list, with the software going live by January 2009.

Bitcoin is sort of like a distributed computing competition, called "mining," where, based on your computational contributions, you have a chance of "winning" a block of bitcoins. This happens every 10 minutes, on average, and the more you participate, the higher the chance of mining a block. The block reward started at 50 bitcoins (BTC), and halves every 210,000 blocks (about four years)—it's currently 12.5 BTC. Mathematically, that means there will never be more than 21 million BTC.

The rewards exist to entice people to run the software, because mining also secures the bitcoin network. Basically, the difficulty of mining a block scales, based on the total speed of the network, called the hash rate, and someone would need to control more than 50 percent of the hash rate to have a reasonable chance of hacking the Bitcoin network. So, the more people (processors) running the hashing algorithms, the more secure the network, and the harder it is to find a block solution. The bitcoin network hash rate has gone from tens of millions of hashes per second during its first year, to billions, then trillions, and it currently sits at roughly two quintillion hashes per second (H/s, with SI prefixes now used). The reason for the increase in hash rate isn't just more people participating—the processors that are used for hashing have gotten much faster, too. Mining started with CPUs, then moved to GPUs, and eventually to custom processors that are designed purely for bitcoin's hashing function. The fastest ASICs now do around 4.7TH/s, which is orders of magnitude faster than the best CPU or GPU.

But what do you do with these bitcoins, and do they have any value? Some might say no, but scarcity, the lack of bank/government control, and their pseudo-anonymous nature has given them plenty of worth in the eyes of others. Anyone can create a BTC wallet, a 26–35 character address that's the public part of a public-private key pair, with the owner keeping the private key. BTC can be transferred between wallets, protected by the power of cryptography, allowing digital funds to move around the world in a matter of minutes. Today, a single bitcoin is valued at over $700 (though pricing is admittedly highly volatile), and more than 100,000 vendors accept BTC, including Newegg. But it's not all sunshine and lollipops.

> “
>
> Today, a single bitcoin is valued at over $700, and more than 100,000 vendors accept BTC.

There have also been plenty of thefts, scams, and other shady goings-on in the bitcoin world. BTC ends up being a lot like digital cash, meaning it's very difficult to trace or intercept. Money laundering, drugs, and other illicit practices have used bitcoin, and ransomware viruses exist that encrypt hard drives and demand BTC to get the unlock code and software. That's both the blessing and curse of the pseudo-anonymous currency.

But despite years of people declaring the death of bitcoin, and others hailing it as the promised messiah, for most people, bitcoin remains a fringe curiosity. It's theoretically possible to make money via mining, but the power cost is nearly as much as the value of the BTC mined. Instead of becoming a currency free from the controls of governments and banks, bitcoin is now largely controlled by a small collection of interested parties, who have heavily invested into the network. And, ironically, greater acceptance of bitcoin will likely come only with more regulation.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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Alex Campbell

OPEN SOURCE

Take Back Control of Your Online Posts

SOCIAL MEDIA USE is pretty much ubiquitous among Internet users. Twitter and Facebook dominate a lot of online traffic, and serve as primary portals to other content on the web. Social media services are convenient, because all of your contacts are likely to be found on there, but not everyone is happy with them.

After years of poring through fake news and partisan vitriol on Facebook, I chose to opt out of the service for a while. Maybe it was the company I chose to keep. Maybe it was the fact that the 2016 presidential campaign, started in mid-2015, kept me on edge for 18 months. Whatever the reason, I felt my blood pressure rise with every login. So, I decided to turn my attention back to my own blog (which I'm paying for, anyway).

By running your own blog, you're not as restricted by terms-of-use (short of hosting illegal content). Even if you do want to keep your Facebook account, running your own blog enables you to use the POSSE model—short for "publish (on your) own site, syndicate elsewhere"—to disseminate your posts. By using this model, you retain control of a central repository for your content. (This is essentially the same model that every major media outlet—including PC Gamer Hardware—uses.)

When building your own blog, you need four things: a server, a DNS provider, a domain name, and software to run the blog. When you purchase a server (a VPS or space on a shared host), the DNS usually comes with the package. You can also run a blog from something as small as a Raspberry Pi at home, but you need a dynamic DNS service to make sure your domain keeps pointing at your home IP address, which can change over time. Domain names can come pretty cheap, if you're willing to grab something outside of the typical .com domain. (Who wouldn't want a .fish domain?)

jekyll

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Static

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Jekyll powers GitHub pages. If it's good enough for GitHub, it's good enough for your blog, probably.

> Even if you do want to keep your Facebook account, running your own blog enables you to use the POSSE model

That leaves you with the software. The good thing about running a blog is that most blogging software out there is open-source. WordPress is the clear leader in the world of CMSes, but it's quite the behemoth to install and run.

Luckily, there are a lot more platforms to choose from. I'm personally running Ghost, which runs on Node.js, and uses Markdown for creating posts. I was recently introduced to Known (https://withknown.com), which utilizes the POSSE paradigm at its core. Known is built in such a way that the software automatically re-publishes your content to the appropriate social media platform based on type (text, photo, audio).

If you're looking for something lighter and faster, there's a lot of work being done on flat-file CMSes. Flat-file CMSes eschew the use of databases (which just demand more security and administration) for flat files that contain the content. What I really like about using flat files is that you can publish with Git if you want (assuming you have a VPS or a shared host that supports Git). There's a great list of flat-file CMSes on Ahad Bokhari's flat-file-cms repo (https://github.com/ahadb/flat-file-cms) on GitHub (the repo is just one Markdown file). Since flat-file CMSes don't require a database, they're pretty easy to set up for testing, which makes it a lot easier to shop for the platform that will work best for you.

Whatever platform you choose, taking back control of your content can be liberating. After all, the most important thing to remember may be this: Love it or hate it, nobody's forcing you to use Facebook.

Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

MAXIMUM PC's FAVORITE CASES OF 2016

7

PHANTEKS ENTHOO EVOLV TG

Phanteks' Evolv ATX case was a favorite from 2015, and with 2016's tempered glass revamp, we love it more, for a sweet $190.

6

CORSAIR CARBIDE AIR 740

Redefining the cuboid-style ATX case, Corsair shakes up its Air series with this fantastic new revision for only $150.

5

FRACTAL NANO S

Fractal's classic Define styling makes its way to the ITX form factor with this stunning windowed chassis for just $70.

4

CORSAIR CARBIDE 400C

With a seriously slick ATX design, this chassis reimagined compartmental cases and perspex windows for a solid $100.

3

NZXT MANTA

The Manta made waves when it launched early in 2016, thanks to its curved panels and compartmentalized ITX layout. Nailing it for only $130.

2

BE QUIET! DARK BASE PRO 900

The world's most modular chassis also includes a wireless Qi charger for your phone. A seriously impressive full-tower for $250.

1

NZXT SOURCE 340 ELITE

This ultimate combination of subtle and sleek has everything you need. This ATX chassis comes in at a phenomenal $100.

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TALKING

BY ZAK STOREY

HyperX Discusses its Keyboard Design and More

Marcus Hermann and Edward Baily talk peripherals

A subsidiary of Kingston, gaming-oriented HyperX has dominated memory and high-end storage, and has created some fantastic headphones. Now it's produced the award-winning Alloy keyboard. We spoke to senior business manager, Marcus Hermann, and Edward Baily, EMEA HyperX business manager, about what the future holds for the company and the peripherals market, and what impact eSports is having on the industry.

Maximum PC: HyperX has something of a legendary reputation among hardware reviewers like ourselves—certainly when it comes to great audio. The Cloud headset, in particular, rattled cages when it first launched for being such a solid product at an exceptional price. Now, we know that was based on Qpad's QH-90 headset, but can you talk to us a little about what made HyperX decide to swallow its pride and go for a design that was already very well established?

Edward Baily: Interestingly, a lot of people don't know this, but we actually partnered with SteelSeries before talking to Qpad at all. We worked to create a fully custom HyperX Siberia V2 gaming headset—this was our first venture into the gaming peripheral market at all. Further down the line, while we were at the DreamHack gaming event in Sweden (a long-term partner of ours), we came across Qpad. Qpad was known in northern Europe for its strong quality and design. However, the company was not as well known globally. It was the perfect size to be an agile partner for us—we could execute product decisions quickly, and help it grow, too, as we did so.

Marcus Hermann: With SSDs, it was actually the same approach—we started off with Intel products, before developing our own models to reach the mass market. We are no stranger to this form of marketing, and it seems to work well.

MPC: A lot of our readers probably won't be aware that HyperX is now its own separate entity from Kingston. Can you talk to us a little about why that decision was made, and how this brand stands on its own?

EB: To clarify, HyperX is a brand that sits under Kingston Technology's umbrella. It's actually quite like how Xbox works with Microsoft. The idea to split the brands out was a way for us to move away from the corporate look and feel of Kingston. And by doing this, we were able to push the boundaries of our marketing (our new Stinger video in the USA, for example), and ultimately address more of a different audience than we could have done previously with Kingston. Kingston still remains as the corporate business professional, while HyperX is pursuing the height of computing, along with eSports as well.

Working with Kingston since 2010, Ed (on left) is certain eSports will lead the way when it comes to technical innovation. Marcus (on right) has worked with Corsair, PNY, and Samsung, before returning to champion HyperX's new leading line of peripherals.

The latest peripheral from HyperX is the Alloy FPS keyboard, reviewed on pg. 88.

MPC: Can you tell us, then, how much involvement does Kingston still have with HyperX's product design? Is it solely designed inside of HyperX, or does Kingston still have the final say?

MH: We still operate shared services—HR and PR, for instance, are still operating across both brands. And so there are still Kingston Technology departments that are involved in the product development side. The product definition and design is owned and driven by HyperX alone.

MPC: Speaking of product design, what was it that pushed HyperX into pursuing keyboards in particular? It is, after all, a heavily contested market at the moment.

EB: It was the obvious product after two and a half years of establishing ourselves as a major gaming headset brand within the industry. Our loyal fans and customers wanted us to further expand our lineup, and bring our quality and expertise to the keyboard world.

MH: We have faith in the strength of our brand, so we are not afraid of our competitors. Extending the peripherals lineup is a logical step on many levels. Gamers care primarily about products that they can touch, rather than what's inside the PC. Out of those products, we only have headsets, but not keyboards or mice. On top of that, it is also a lot easier to break into larger retailers if you can fill a shelf with the various peripheral products, rather than just the one product or two. We intend to become a significant peripherals brand in terms of revenue and units, and you can't do that just with headsets.

MPC: The Alloy is, by far, one of the nicest keyboards we've had the pleasure of reviewing this year. Can you tell us a little about what design considerations you made when setting out to craft the initial concept? What was it that you wanted to focus on in particular?

MH: First of all, thank you! We are probably the brand that is the most active in eSports, in terms of team and event sponsorship, so it made sense to develop a product that would ideally resonate with that target audience. We understand that, globally, *LoL* is the most popular game, but we identify that FPS games are, by far, the fastest growing gaming genre out there, particularly driven by *CS:GO.* Another popular title is *Overwatch.* With this in mind, we designed a keyboard that would be quite well suited to play FPS games. Usually, you play FPS games with a low dpi setting, which requires a lot of space for your mouse movements. The less space the keyboard takes up, the better—so that's why the Alloy FPS is as compact as it is.

MPC: Going with the Cherry MX Blue switch initially, as opposed to the MX Red, is a bold move, especially as the Red is often the key touted across global marketing as being the "gaming" switch. Can you tell us why HyperX made that decision?

MH: We always developed this product with three switches in mind. So, after Blue, we will release a Red and Brown version, too. We decided to launch the Alloy FPS through staggered regional launches, and China was part of our first wave, where the Cherry MX Blue is by far the most popular switch. We had faith that a good product, in addition to our brand strength, would carry the product, and the initial numbers have proved us right. An Alloy version with Red and Brown switches will be announced at CES.

MPC: We've seen a wide range of headsets, memory, keyboards, and even mousemats added to your lineup—the question has to be asked? Is a gaming mouse on the cards any time soon?

EB: We have a lot of exciting peripheral products coming in 2017. You will just have to wait and see!

MH: We don't have an official comment on this yet, but the previous answers should make that pretty clear.

MPC: How do you see the peripheral market looking right now? We have companies like Mionix claiming it's stagnating, trying to radically innovate with things such as heart rate and GSR sensors. But what's your or even HyperX's take on the whole situation?

EB: Interesting you mention Mionix—I actually invested in the Kickstarter project for its new gaming mouse, the NAOS QG. At HyperX, we are big fans of what Mionix has done, and how it is innovating inside of the gaming market. From our side, we only see the gaming market growing every year. PC gaming is at an all-time high, with sales booming. If you look at eSports, the revenue will grow 51 percent year on year, to $493m in 2016, according to NewZoo. All of those gamers in eSports need the best gaming peripherals in the market, and this is why we are heavily invested in the eSports community.

MH: As far as the peripheral market is concerned, it is a common phenomenon that fast-growing markets have less pressure to innovate. Other than RGB keyboards, there were a few ideas that so far haven't taken off just yet.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Storage Technology
> Budget Builds
> Laptop Upgrades

Upgrade or Replace?

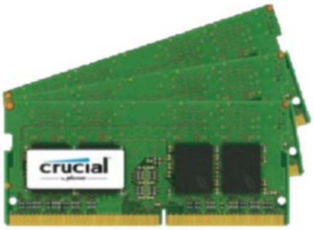
Dear Doc, ever since a friend recommended your magazine in 1999, I've been hooked. It made me want to build my own rig. I love the combination of hardware and software, and the trends you introduce. Keep up the great work!

After all that time, I finally put together a rig for my 10-year-old son last year. It's a family hand-me-down with a few upgrades. When he's ready for a better gaming experience on his birthday or Christmas, what are the best upgrades available? He's playing *Fallout 4, The Elder Scrolls V: Skyrim,* and *Assassin's Creed Syndicate* at medium quality presets.

The system is an HP Pavilion p7-1007c, with an AMD Phenom II X6 1045T, 16GB of Patriot DDR3-1600 memory in two 8GB sticks, an Nvidia GeForce GTX 660, and a 650W power supply. The cooling is stock; nothing is overclocked. I recently bought an MSI GeForce GTX 1060 Gaming X 6G. If I put it into this PC, will a bottleneck somewhere else limit the card's performance? I have another system it was destined for, but that's another story entirely.

Thanks for any help you can provide to a long-time *Maximum PC* fan in Phoenix!

–Joaquin Pantel



Adding a DDR4 SO-DIMM to your laptop may not do as much for performance as you'd hope.

THE DOCTOR RESPONDS: The Alvorix motherboard in your HP system supports up to 95W CPUs, and the Thuban-based Phenom II X6 is top of the line for its Socket AM3 interface. That rules out a CPU upgrade.

A GeForce GTX 660 is already quite an upgrade from the Radeon HD 4200 graphics built into AMD's 785G chipset. However, the GeForce GTX 1060 should be notably faster if you choose to send it your son's way. A conservatively clocked CPU like the 1045T might hold the 1060 back a bit, but high-quality graphics settings should be available at playable frame rates on an FHD display. Of course, it helps that someone stripped out HP's stock 250W PSU and replaced it with a 650W upgrade somewhere along the line.

How about an SSD? If the p7-1007c is still leaning on its stock 1TB drive, you're losing a lot of responsiveness to the mechanical disk. Even a 128GB or 256GB SSD for your son's favorite games would cut level load times tremendously.

Storage Confusion

Hey Doc. I'll be building a new PC in the near future and I'd like to know which SSD to use. I'd like an Intel PCIe or M.2 drive. However, I'm unsure if my OS will boot from it. I'd prefer to use a single storage device, so I'm springing for at least 1TB of capacity. I understand that some SSDs aren't bootable. Can you help clarify the ins and outs of an upgrade? **–Ken Payne**

THE DOCTOR RESPONDS: A lot of new storage-oriented terms and technologies were thrown at PC builders in 2014/2015. Suddenly, client SSDs could be attached directly to the PCIe bus. There were also the NVMe and AHCI non-physical interfaces to consider. Finally, motherboards started including M.2 slots, supporting legacy SATA SSDs, PCIe-based SSDs communicating through AHCI, and NVMe PCIe drives.

Whether or not your PC will boot from a modern Intel SSD depends on several factors. First, your motherboard must have the right firmware. Many board vendors enabled support up and down their Z97- and X99-based portfolios in 2015. Check that the latest UEFI version is installed, and that it explicitly calls out NVMe support. Next, what OS are you using? Windows 8.1 and 10 support NVMe PCIe boot devices natively. Win 8 requires additional drivers during installation. Hold-outs with Win 7 need a specific Microsoft hotfix, though even then mobo compatibility is dicey.

Intel sells two 1TB-plus PCIe SSDs: the SSD 600p and SSD 750. The former is available as M.2, and qualifies as somewhat mainstream (peak sequential writes of 560MB/s aren't much faster than SATA 6Gb/s). SSD 750 drives are markedly faster. You'll find them in familiar 2.5-inch packaging with an SFF-8639 connector, or as expansion cards that drop into a PCIe slot. Both high-performance models require airflow over them, so plan on purchasing an extra fan or two if you opt for the SSD 750.

Be warned that high-end PCIe-based drives command a premium. And while they're great if you need massive throughput, SATA is viable in most enthusiast environments.

Long Windows Update

Dear Doctor, I know my PC and OS are old, but I really like the

↘ submit your questions to: doctor@maximumpc.com way they're set up. Most of my work on this machine involves Outlook, web browsing, and listening to music. In many ways, I find it easier to control than my Windows 10 PC.

Here's the issue I'm having with my HP Pavilion m7790y running Windows Vista: Two or three months ago, Windows Update stopped working, even though Microsoft still officially supports the OS. When I click "Check for Updates" or "Automatic," I get an endless cycle of checking with no results. I've tried this several times, letting it run for hours, with no luck. I tried Safe mode, toggling updates off and back on, and disabling apps that run in the background. Nothing works. I even tried System Restore, but that didn't go far enough back to cover my last good configuration. Microsoft Fix It wasn't any help, either.

Although I've tried to diagnose the issue by searching online, none of what I've found matches my situation exactly. I'm guessing that something needs to be reset in the registry, but I need an expert like you to help. I've been a subscriber for 18-plus years! **–Gary Leonardo**

THE DOCTOR RESPONDS: The Doc doesn't have a PC with Windows Vista installed, unfortunately, so he can't verify the efficacy of this fix. However, a Microsoft Community member has a procedure that other folks are finding helpful. Check out https://goo.gl/5sNwgt for details. The Windows Update Agent is broadly blamed for the delays you're experiencing.

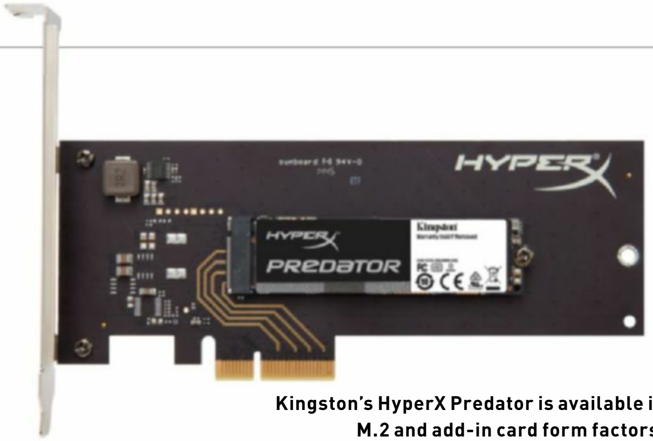
Although Vista is still officially supported, its lifecycle does end in April 2017. Further, Microsoft introduced a patch in June 2016 to solve the same issue in Windows 7. While your setup seems to be running fine otherwise, Vista is clearly on the way out, and it may be time to consider upgrading.

Pro PC on a Budget

Here's the skinny, Doc: I'm a mechanical engineering major, and have come to the realization that I may need a beefier rig. I'm a gamer at heart, but have also put my machine through its paces with rendering and design projects. At this point, I believe I'd benefit from newer technology, as my hardware is going on four years old.

Is there any way to put together a workstation and gaming machine that even a college brat could afford? Or, could you help me with a list of worthwhile upgrades for an ageing Haswell-based system? Thanks for the help.

–Christian Waters


Kingston's HyperX Predator is available in M.2 and add-in card form factors.

THE DOCTOR RESPONDS: Has it already been that long since the Haswell architecture was introduced? The Doc doesn't know which fourth-gen Core processor you currently use—a dual-core i3 needs replacing far more than a quad-core i7. However, neither Broadwell nor Skylake represent significant enough upgrades to suggest swapping out your CPU, motherboard, and memory.

A similarly old graphics card would probably put you in GeForce GTX 700/Radeon R9 200 territory. Nvidia's GeForce GTX 1070 is one of the Doc's favorites right now, both for its ability to outperform the previous-gen flagship, and its availability under $400. That would probably be your most rewarding upgrade.

Not sure where you are with storage, but an SSD is mandatory. And make sure important school projects, movies, and music are saved to a redundant array—whether that's a couple of internal disks or a networked appliance. And if you're currently gaming/working on a single monitor, strongly consider a second or third. The Doc swears by three for maximizing productivity.

Upgrading a Laptop

Doctor, as a long-time reader, I trust your sound advice. I recently bought an Acer Aspire E5-575G-53VG laptop. To my surprise, it has an open RAM slot, and the system drive is a 256GB M.2-based SSD. It also has an available SATA bay for adding more storage. Even with its discrete GPU, it lasts for 10 to 12 hours on a full charge.

I am considering adding another memory module and a second hard drive. Should I buy a Samsung 850 EVO SSD or save money and go for a mechanical disk? Is it worthwhile to swap out the M.2 card for a 512GB Samsung SSD? I am looking to extract as much speed as possible from this laptop, because it needs to last me at least three years. I mostly use it for traveling and some discreet gaming while I am on the road. It runs *Fallout 4* at moderate detail settings right now, so I expect it to be decently fast for a while yet. Your advice is greatly appreciated. **–Stephen Fraser**

THE DOCTOR RESPONDS: You have to love upgradeable mobile platforms. The E5-575G-53VG comes with 8GB of DDR4 in an SO-DIMM format, so feel free to add a second 8GB module. Just don't expect that to have a resounding impact on performance. The same goes for storage. A 256GB SATA 6Gb/s SSD, which is what that machine sports, is going to be fast and responsive. Higher-end SSDs might be a little faster and a little more responsive, but adding capacity is the only way the Doc could justify a replacement. As for your empty bay, pop an inexpensive mechanical disk in there. That 256GB SSD will only stretch so far, and 2TB hard drives sell for under $100.

Unfortunately, the go-fast parts that'll keep you happy with your Aspire for another three years aren't serviceable. The laptop is competent for under $600, but consider its unpopulated ports and slots an extension of functionality, rather than an opportunity to exploit untapped potential.

BIOS Follow-Up

Doc, I was the one who asked about the Acer BIOS the other month (thank you for your help clearing that up). I looked but cannot find a download link. I still want to update the firmware to get as much as I can out of this machine, at least until I can afford to build a beautiful new PC. Could you point me in the right direction?

–Trevor Giampieri

THE DOCTOR RESPONDS: The Doc pulled your system's BIOS information from Acer's support site. The latest version is downloadable from https://goo.gl/cLSttx. ⏻

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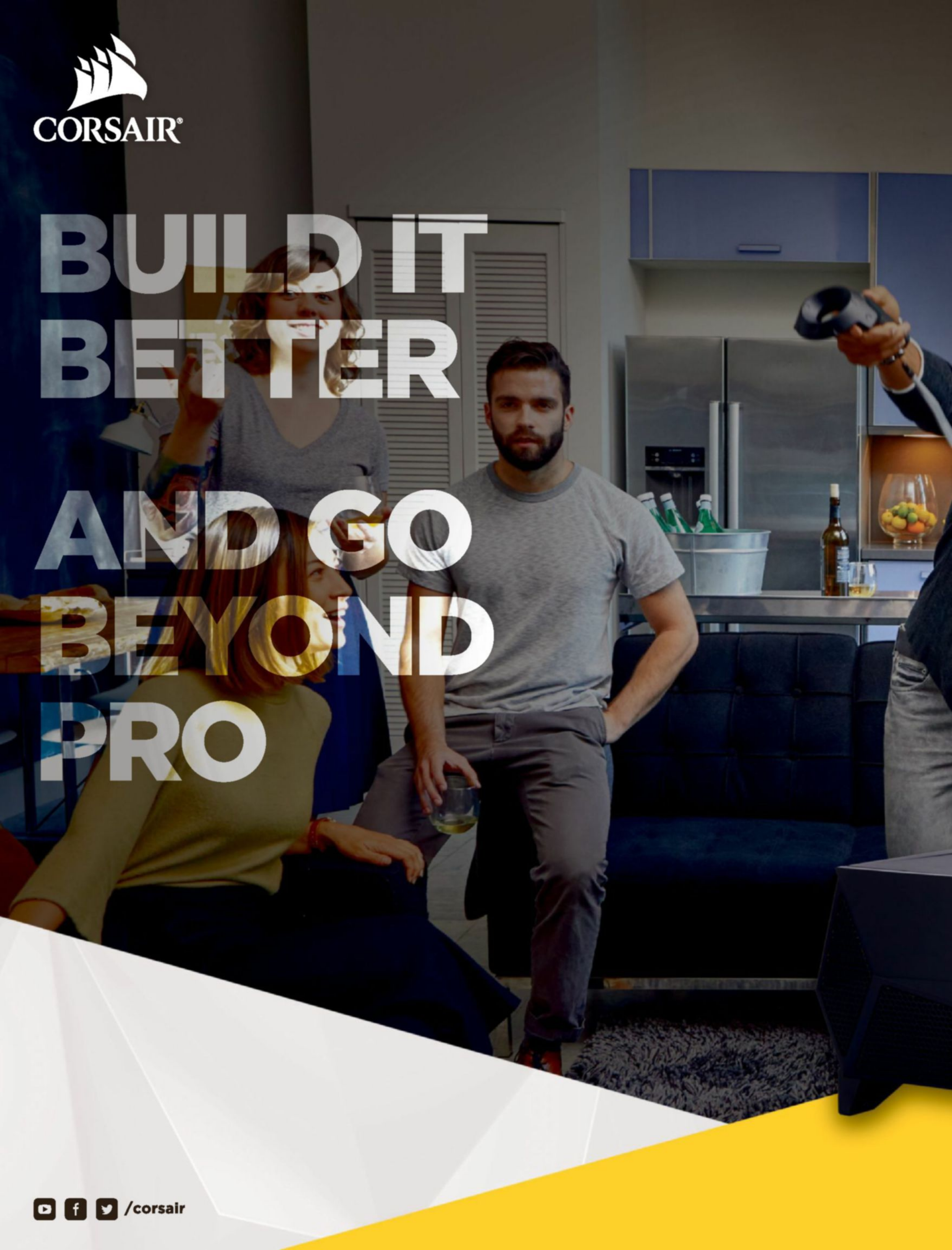
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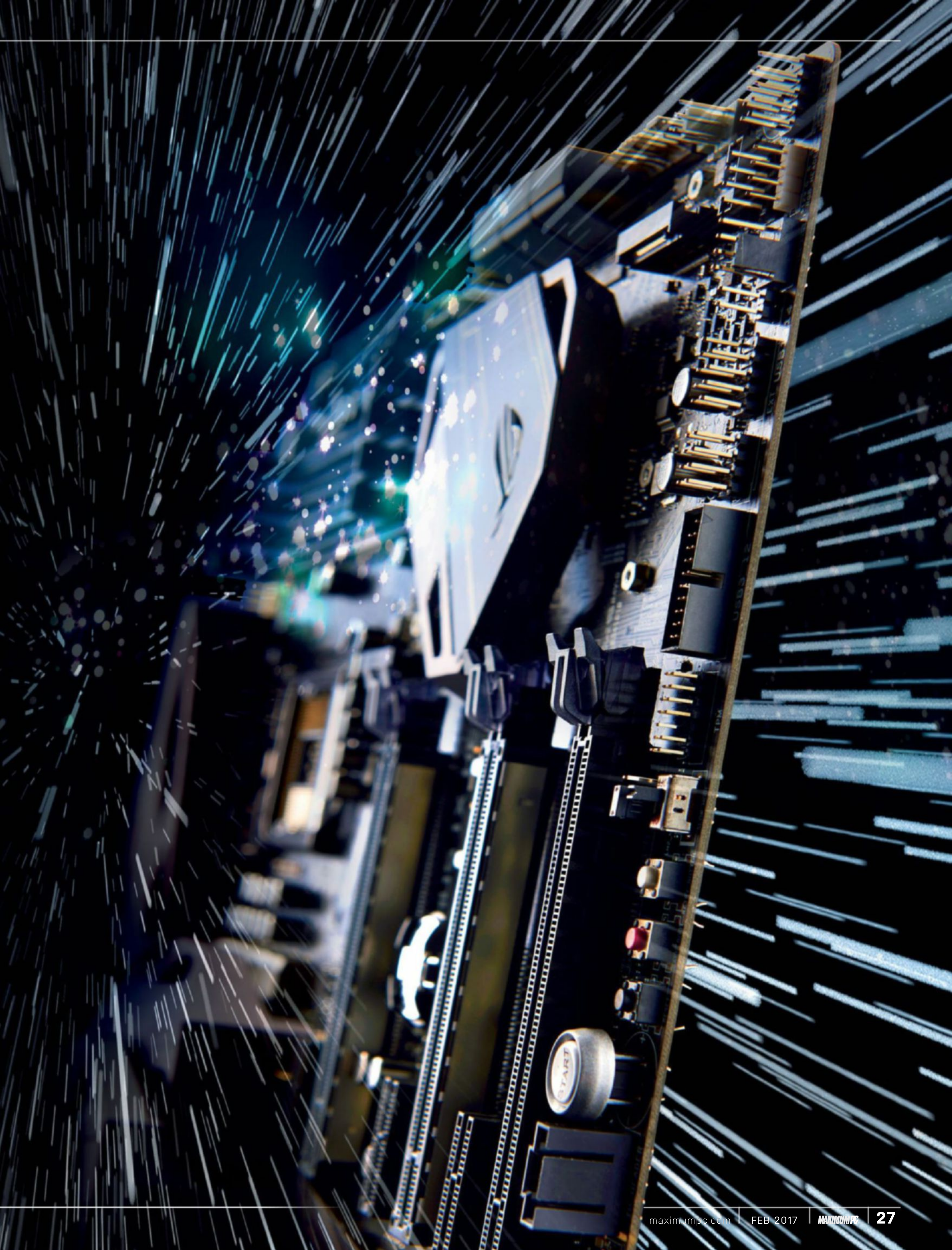
2017 TECH PREVIEW

The last 12 months saw incredible steps forward for our beloved PCs, but what's on the horizon? Where are things going next? We sort through the rumors and lies to discover what is really lined up for the next year, when new kit should arrive, and where it's going to take us

By the Maximum PC staff



A NEW HOPE

AMD's new Zen CPU takes aim at the Intel empire

Not to put too fine a point it, but expectations are nothing if not high for AMD's upcoming Zen CPU architecture. We've previously branded it as being everything from a new hope to AMD's absolute last chance for survival. And as we look forward to 2017, the year Zen will finally arrive, it feels every bit as portentous as all that—Zen is a really big deal.

That's chiefly because competition improves the breed, and ever since AMD launched its failed Bulldozer architecture back in 2011, Intel hasn't really had any competition in the PC processor market. The consequence of that has been a state of general stagnation in terms of mainstream CPU performance on the desktop. Intel's processors have been quad-core items, and have only improved very marginally in terms of conventional CPU performance over the past five years.

It's into that context that we're hoping AMD can drop a big old bomb with Zen. The good news is that there's every reason to be optimistic. For starters, AMD has been fairly open about the errors of Bulldozer's ways. So, say goodbye to Bulldozer's radical modular architecture. Zen switches back to heavy-duty CPU cores, each with a full set of their own resources for crunching through as many instructions per clock cycle as possible. Zen also packs simultaneous multithreading, which means each core can process two threads in parallel. Sound familiar? It's just like a modern Intel chip.

AMD's aim with Zen is to increase the number of instructions the architecture can process per clock cycle—otherwise known as IPC—by 40 percent over existing AMD cores, without increasing power consumption per cycle. Sounds good, but will Zen deliver? AMD has demonstrated an eight-core Zen chip beating a same-clocked eight-core Intel chip by a small margin, albeit in a single benchmark. Also, the brain behind Zen happens to be Jim Keller. The same man who gave us AMD's killer Hammer architecture back in 2003. Then again, more recent rumors have suggested an eight-core Zen will offer performance more in line with a six-core Intel processor.

Anyway, it's thought that AMD will start with just one Zen CPU die for desktops, an eight-core design called Summit Ridge. If AMD really does inject an eight-core chip into roughly the same space as Intel currently operates with quad-core chips, that really will be a revolution. Watch this space.

AMD
64
Athlon X2

Remember when AMD had properly competitive CPUs?

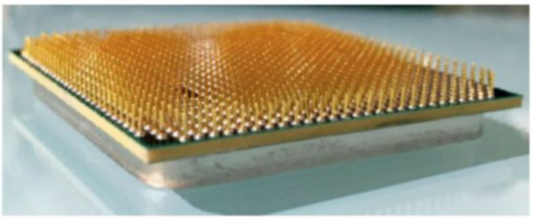
A PLATFORM FOR SUCCESS

If AMD's CPUs are looking crusty, its platforms and chipsets could also do with being taken out with the trash. Native support for modern high-bandwidth interconnects and storage are conspicuous by their absence. Put another way, even if AMD's new Zen CPU architecture delivers on its promise, that will only be half the job done. AMD needs some new platforms, too. A warm welcome, therefore, for AM4, AMD's new socket, and the X370, B350, and A320 chipsets.

AM4 will also come with support for DDR4 system memory. But it's elsewhere that the real interest lies. The new platforms seem to have all the bases covered: Nothing is official as we go to press, but NVMe and M.2 storage, plus native USB 3.1 Gen 2 and PCI Express 3.0 are all reportedly in the mix, according to leaked documents.

The top chipset is the X370. That will pack dual x16 PCI Express 3.0 ports for multi-GPU action. X370 will also have a full range of overclocking features. Beyond that, not a great deal is known. We certainly hope that additional PCI Express 3.0 lanes will be available to allow dual graphics, plus a high-speed PCIe SSD.

There's reason to think that, as leaked details about the mid-range B350 chipset indicate it will come with support for two PCIe drives, although the actual number of lanes available to each drive isn't clear. All told, it looks promising, and exactly what AMD needs to complete its next-gen offering. All the indications are that Zen and its supporting platforms will be announced very early in 2017, so here's hoping Intel finally has a fight on its hands.



Pins, pins, pins: AMD's new AM4 socket will have to accommodate 1,331 of the pointy little things.

INTEL'S CONFUSING NEW CPUS

A six-core mainstream Intel CPU at last?

Tick-Tock is dead. Long live Process, Architecture, Optimization. It's no secret that the whole chip industry is now having trouble keeping up with Moore's Law, hence Intel dropping its Tick-Tock cadence, and with it a commitment to die-shrink its CPUs every other year.

However, what is a little surprising are rumors involving yet another 14nm CPU architecture to follow the freshly-minted Kaby Lake. The first 14nm family was, of course, Broadwell, which begat Skylake, which was, in turn, usurped by the aforementioned Kaby Lake. But the latest leaked CPU road maps from Intel indicate a hitherto unknown family of chips called Coffee Lake.

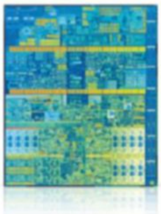
Nothing is certain, but the indications are that Coffee Lake will be 14nm. That's a surprise in itself, but the really intriguing development is the addition of a six-core Coffee Lake model for mainstream sockets. If true, it will be the first six-core mainstream chip from Intel for desktop PCs. The six-core chip will also find its way into laptop PCs.

We can't help noting that the emergence of Coffee Lake coincides with AMD nearing launch with its Zen architecture. Already, it seems, Zen is influencing the CPU market for the better. A mainstream six-core CPU from Intel is long, long overdue, and almost certainly hasn't happened before because AMD hasn't put Intel under any pressure for the past five years or so.

Coffee Lake is due in 2018, so a little after Intel's first 10nm chips, known as Cannon Lake, and penciled in for late 2017, albeit only for mobile PCs. One major change with Cannon Lake is embedding the PCH chip in the CPU die, making Cannon Lake more or less a full-fledged SoC, or System-on-a-Chip. That will be very interesting from a mobile PC perspective, in terms of power consumption and packaging. It should enable some fairly exotic designs in terms of compactness, and squeezing true desktop performance into smaller designs than ever before.

Beyond that, relatively little is known about Cannon Lake, or indeed its 10nm successor, Ice Lake. Talk of eight-core Cannon Lake chips has circulated, but at this stage that is highly speculative. Given that Cannon Lake is ostensibly just a die shrink of Kaby Lake, it's perhaps Ice Lake that you might expect to bring major architectural innovations. But given the flux Intel's road maps have suffered of late, we wouldn't rule anything out over the next year or three.

Looks as though Kaby Lake won't be Intel's last 14nm design.



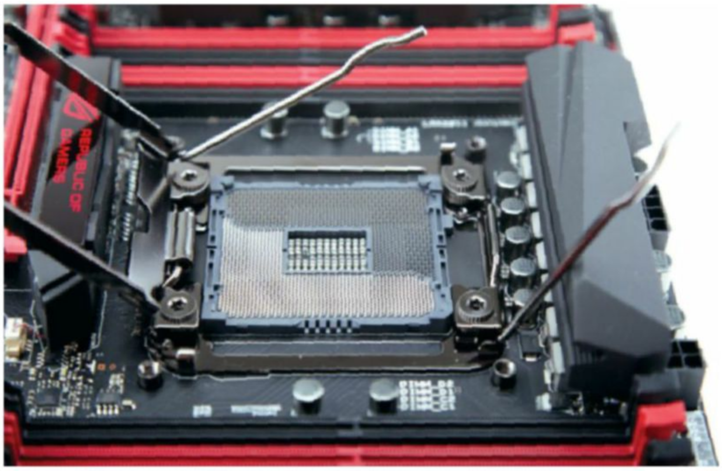
INTEL'S NEXT-GEN SUPER-CHIPS

Intel's Kaby Lake chips are now shipping in both mobile and desktop form, which means Intel's high-end platform finds itself in the odd position of being fully two generations behind in architectural terms. Currently, the Core i7 Extreme Edition lineup, including the monstrous 10-core i7-6950X, is based on the Broadwell-E architecture.

With that in mind, it makes a certain kind of sense to find that Intel is preparing a double whammy for its high-end desktop series in 2017. It seems both Skylake-X and Kaby Lake-X chips are go for launch.

Skylake-X will be the bad boys of Intel's 2017 range, rocking in with six, eight, or 10 cores, and TDPs up to 140 watts. Sky Lake-X chips will also pack as many as 44 PCI Express 3.0 lanes for massive I/O capability, along with a quad-channel memory controller. That said, Intel already offers a 10-core CPU, so it remains to be seen whether Sky Lake-X will be much of a step forward for raw performance.

Kaby Lake-X, meanwhile, will be limited to a mere four cores, 16 PCI Express lanes, and a dual-channel memory controller. If that seems like a retrograde step, our best guess is that the Kaby Lake SKUs may be a pre-emptive response to AMD's new Zen CPUs. AMD will be offering a full range of traditional Zen CPUs without integrated graphics, and Kaby Lake-X could be an attempt to see off the bottom end of the Zen offering. Whatever, both of these new CPU families from Intel will slot into the new LGA2066 socket, breaking backward compatibility with existing LGA2011 platforms and chipsets. Consequently, a new platform and chipset, codenamed Basin Falls-X, will arrive. Highlights will include up to 10 USB 3.0 ports, and up to 24 lanes for PCI Express storage.



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TEAM RED PIXEL PUNCHERS

Where have we been and where are we headed?

2016 has been a year of graphical revolution. We finally transcended the confines of 28nm down to 16nm and 14nm. Big wins have been made for both Team Red and Team Green, as performance-per-watt figures spiked in celebration of this new transistor size. But, it hasn't been a bed of roses for the guys at AMD. With an early entry into the mid-range battlefield, AMD clawed market share back from its green rival, but seven months on from the launch of the price-to-performance dominator that was Polaris and the RX 480, we've still seen nothing in regard to a true endgame from AMD. Nvidia is left to reap the rewards, dominating the field with the GeForce GTX 1080 and 1070, able to price itself wherever it pleases. So where are we heading?

The answer is Vega. A plethora of rumors surround the card, but all we know for sure is that it will be debuting in the first quarter of 2017. With it likely to be revealed at CES, by the time you read this, it should have been announced.

At a guess, we expect this new GPU architecture to still be based on GlobalFoundries' 14nm FinFET manufacturing process, featuring twice as many compute units and shader cores as the RX 470—around 4,096 cores in total. In terms of memory, it's a widely held belief that these cards should come packing HBM 2.0, and the delay is due to AMD trying to work the bugs out of the manufacturing process. With 16GB of HBM 2.0 being the top end, we can expect somewhere around 512Gb/s total memory bandwidth.

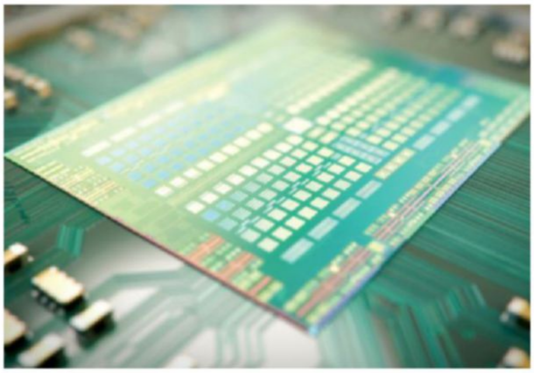
Alongside Vega 10, we're expecting a cutdown variant of the new architecture, known as Vega 11. This should be the spiritual successor to the RX 480 and the original Polaris chips. Based on the same architecture as Vega 10, we expect it to come with around 30 percent fewer shaders and compute cores, and perhaps even a drop down into HBM 1.0 and GDDR5 memory, hopefully with a TDP of less than 75W on the lowest end of that spectrum.

This will likely be followed by a rebadging of the Polaris architecture at the bottom end. It's hard to say what the nomenclature will be, but our money's on AMD dropping the RX 400 series, and opting for the RX 500 series instead.

BEYOND THE BEYOND

With AMD and Nvidia announcing their product timelines publicly, we can comment on a few items that we know for certain are coming over the next few years. We know that Vega 10 and 11 should be dropping in 2017, to be followed by AMD's transistor shrink in 2018 from 14nm to 7nm, thanks to the help of GlobalFoundries. This means we could expect to see a dual-cored, 7nm card in only two years. Vega 20 (all hypothetical from this point onward) should come packing a phenomenal 32GB of HBM 2.0 for a mind-boggling 1TB/s of total memory bandwidth, and a scarily huge 8,192 shader cores. That's around nine times more transistors than found in a single RX 470—45.6 billion on a single GPU.

Vega 20 sounds insane, and for now is just rumor. But when you consider that alignment with GloFo's 2018 goals, and the fact that AMD will launch its new Navi architecture in 2019, it's a lot more reasonable to expect Team Red to produce a 7nm dual-cored test subject, before dropping a new architecture on top of a die shrink simultaneously.



Soon, Polaris 10 will be replaced by the far superior Vega 11 architecture.

THE MEMORY CONUNDRUM

After last year's bonanza, with GDDR5X and HBM making it to market, and DDR4 cementing itself into Z170/B150 chipsets, little looks likely to change for memory. DDR4 will still hold true in the mainstream platforms, with AMD's Summit Ridge and Kaby Lake supporting it. While, no doubt, frequencies will continue to rise, alongside a drop in the cost per GB, there'll be little in the way of revolutionary change. Quad-channel will still be limited to HEDT variants, as Skylake-X retains the mammoth bandwidth standard, with Kaby Lake-X holding on to the dual-channel heritage.

HBM 2.0, on the other hand, is a real game changer. Over the last year, we've seen game developers take ever greater advantage of larger frame buffers and faster memory bandwidth, and with GDDR5 taking a backseat in terms of PCB space consumed versus memory transfer speeds, HBM filled that gap. Unfortunately, HBM 1.0 is still a flawed standard, only capable of supporting up to 4GB of VRAM at 512GB/s total bandwidth (each stack supporting 128GB/s). HBM 2.0 looks to remedy that situation, enabling 4GB of VRAM at 256GB/s per stack, allowing for a total of 16GB at a combined memory bandwidth of 1,024GB/s.

Volta will most likely appear in May, replacing Tesla P100 for supercomputers.

LIFE AFTER PASCAL

Building on a winning formula

Nvidia had a phenomenal 2016, thanks mainly to it being able to sort out its 16nm production process, and put it to good use with its Pascal architecture. Star of the show was, and still is, the GTX 1080, although for those with a more reserved eye on their bank balances, the likes of the GTX 1070 and 1060 have possibly had more sway in actual upgrades. Meanwhile, at the top end, the new take on the Titan X won plenty of plaudits, if you could afford premium pixel pumpers, and could actually find a reseller with stock.

Fast-forward to 2017, and we should see the last logical addition to the family, the GTX 1080 Ti, make an appearance. It's rumored to sit between the Titan X and the GTX 1080, with a specification and price to match. The reason that it hasn't been released sooner than this? There hasn't been a need for it—AMD doesn't have a competing card at the high end to take on the GTX 1080, which means Nvidia has been able to employ a wait and see approach to proceedings. We will probably see the 1080 Ti as a response to an R9 490X. Expect 10GB of GDDR5X on the GeForce GTX 1080 Ti, 60 streaming multiprocessors, and a sub-$1,000 price tag.

The next major GPU architecture from Nvidia goes by the codename Volta, and we could see the first GPU based on Volta as soon as May—it's expected to appear at the Graphics Technology Conference. Volta was originally planned for release in 2018 using the 10nm FinFET production process, but given the pains Nvidia and TSMC have had shifting to 16nm, it's no surprise that the transition has been delayed. So, Volta will use the same 16nm process as Pascal, but benefit from a few tweaks in a move that is reminiscent of Intel's Tick-Tock updating regime.

Details are scarce, but we know Volta will support stacked RAM, aka HBM 2.0 (see "The Memory Conundrum" opposite). The expectation is that Volta will do much better when it comes to asynchronous compute, too, as used by DirectX 12 and Vulkan. Despite the fact that Pascal has been warmly welcomed commercially and critically, AMD still has the edge when it comes to some DX12 code paths.

WHERE NEXT FOR VR?

While the HTC Vive and Oculus Rift work well enough, the price barrier is enough to prevent either from really taking off—we're not just talking about the headsets, as you need a powerful graphics subsystem to drive a pair of HD displays at 90Hz, too. Indeed, a recent sales report puts both headsets as being minor in the overall VR market, with Google Cardboard leading the pack, and Sony's PlayStation VR already making interesting inroads.

Even so, as many have predicted, the big challenge for VR is on the software side—creating a believable VR experience can be incredibly expensive, and even the most impressive titles so far have been either very limited in scope or very short-lived. We still think there's plenty of room for more non-gaming experiences, too, but without a sufficient installed user base, we can't see radically new experiences emerging anytime soon. It may be Sony's offering that starts the ball rolling here, but we'll have to wait and see where this is going.

What we do expect in 2017, though, is an influx of new VR headsets, something that will be partly driven by Microsoft's bullish entry into the market. Microsoft's interest in VR headsets for Windows 10 may well be a stepping stone to its HoloLens technology, but with the weight of the hardware industry behind it, renewed competition can only help. Headsets are expected from HP, Lenovo, Dell, Acer, and Asus, with suggested retail pricing starting at $299. In fact, that pricing alone may be all that's needed to get VR into more homes, and then surely the titles should start rolling in.

INTEL'S AWESOME SSD TECH

Will Optane drives finally arrive in 2017?

There's a performance bomb heading for the solid-state storage market. That's what we said this time last year. But it never happened. Not as we hoped, at least. To put it another way, Intel and Micron's 3D XPoint memory technology, known as Optane when applied to Intel SSDs, never materialized.

Of course, 3D XPoint is a radical new type of memory tech, not an incremental improvement, so it's not exactly shocking that it's taking longer to hit the market than expected. But before we consider whether it will finally appear in 2017, it's worth recapping why it's so exciting.

3D XPoint is a non-volatile memory tech that's claimed to be up to 1,000 times faster, 1,000 times more robust, and 10 times denser than the conventional NAND flash found in existing SSDs. Staggering stuff, but how does it work?

Unlike NAND flash, which is composed of memory cells consisting of gates in which electrons are trapped, 3D XPoint uses electrical resistance to store data. Each cell stores its bit of data via a subtle change in the conductive resistance of the cell material. A benefit is that this doesn't require a transistor, and that means each cell can be smaller, so more can be packed into a given area of memory chip. That means higher densities and more storage.

The other major difference is the fact that 3D XPoint's memory cells are addressable at the individual bit level. That's a dramatic change from NAND, where whole blocks of memory, usually 16KB, must be programmed to save just one bit of data. The consequences for NAND flash are time-consuming read-modify-write cycles, and the need for complex garbage collection algorithms. That's all gone with 3D XPoint, which should mean massively improved random access and IOPs performance.

Of course, much of that is theoretical. Early demos have shown random-access performance around five times faster than a current top SSD. Not quite 1,000. But imagine if Intel launched a CPU that was five times faster. Quite.

If that covers the technicalities, what's the latest on any of us being able to buy an SSD with 3D XPoint tech? The only thing we know for sure is that Intel will be selling its 3D XPoint SSDs under the Optane brand. There has been some debate over what form that will take, including implications that it would be a whole new memory class, acting as a sort of high-speed cache, rather than mass storage.

More specifically, certain system configurations with an Optane drive will support a software-defined cache hierarchy, where the CPU's addressable memory space is a combination of RAM and the SSD. But that tech is aimed more at heavy-duty database work than desktop PCs. With that in mind, Intel's first step with Optane will be Optane-based testbeds designed for cloud computing. Intel is partnering with Facebook to test the technology, and it's possible the latter is already using Optane to some extent.

However, the good news is that it's probably conventional Optane SSDs that will hit the market first. That's because using 3D XPoint as a system cache requires the creation and fine-tuning of a new software abstraction layer. Optane SSDs using the 3D XPoint technology could be plug and play with any modern PC. The only question is when that will happen. Back in mid-summer, some Intel road maps leaked, indicating a very-late 2016 launch. As we write these words in the dying days of 2016, that still hasn't happened.

More recently, there has been talk of Optane drives launching with Intel's new Kaby Lake seventh-generation Core processors. But just to really confuse things, those Optane drives are mooted at 16GB and 32GB capacities. In other words, so small that the implication is that they are cache drives, not mass storage SSDs.

The bottom line is that Optane isn't out as we go to press, and it's not clear when that will happen, or what form it will take. We still think it will be a killer technology—and, with any luck, 2017 will be the year it finally delivers. In the meantime, 2017 will see ever faster variants of what you might call conventional SSDs, but it will still look pretty exotic. Samsung's new 960 Pro is likely a harbinger of things to come. M.2 and PCIe SSDs with GB/s of bandwidth will probably be fairly routine by the end of 2017.

SAMSUNG
NVMe SSD
960 EVO
M.2
1TB
SAMSUNG
2TB

SSDs continue to push forward both in terms of capacity and throughput.

HIGH DYNAMIC RANGE IS COMING

Get your retinas ready for HDR screens

Conventional wisdom has it that screen technology usually develops gradually, and is only occasionally punctuated with major developments. If that's true, somebody has gone crazy with the exclamation marks of late when it comes to PC monitors. The pace of change is almost out of control, and 2017 looks set to see more of the same.

We've already seen so many innovative new features become mainstream in the last 18 months or so. How about frame-synching tech, such as Nvidia's G-Sync and AMD's Freesync? Or high refresh panels capable of 144Hz or more? Or curved screens, super-wide aspect ratio screens, 4K screens, and more?

For 2017, all of those features should become ever more affordable. But the really big news is likely to come in two forms. The first, and the one that's a dead cert, is HDR, or high dynamic range technology. In simple terms, it means screens will be both brighter and darker—they'll operate over a wider range. If that's sounds a little abstract, in practice it means screens with staggering levels of visual pop and vibrancy. So, now that 4K has arrived and given us millions and millions of pixels, HDR is all about making each pixel work much harder.

HDR is a technology that's already rolling out across much of the HDTV market, and at relatively affordable prices. Indeed, there's nothing stopping you from picking up an HDR HDTV, running it with one of the latest Nvidia or AMD GPUs via HDMI 2.0, and getting in on the action immediately. The only snag is that HDR content, particularly games, is extremely scarce. Still, buy an HDR panel now, and you'll benefit from features such as much improved contrast and local backlight dimming. For that reason, we're very much looking forward to the first dedicated HDR computer monitors in 2017.

The other piece of the 2017 puzzle for screens is the ever-tantalizing promise of OLED technology. OLED HDTVs finally got some traction in 2016, albeit at a hefty price, and a couple of OLED laptops popped up, too. We still don't expect OLED to go mainstream in 2017, but it should become gradually more prevalent. So, depending on where you are in your monitor upgrade cycle, and no matter how tempting a conventional LCD panel may be, even with HDR capabilities, it might just be worth holding out for that OLED awesomeness.

4K
HDR
ULTRA HD

High dynamic range is set to shake up the screen market once more.

NETFLIX 4K COMES TO THE PC

4K TVs are now a dime a dozen. In that sense, you'd be mad to buy a new HDTV that wasn't 4K. That's true despite the fact that there's relatively little 4K content to watch. For the PC, however, the same logic doesn't quite apply. At least, it hasn't done up until now.

That's because what little 4K content does exist hasn't tended to be available on the PC. Mainly, that reflects DRM and pirating concerns, which meant streaming video providers like Netflix have declined to open up their 4K streaming for the PC. It's been reserved for closed set-top boxes and smart TVs.

However, that could all be set to change with the introduction of Intel's new Kaby Lake seventh-generation Core CPUs, known as the 7000 Series. The big news involves new DRM features built into Kaby Lake's 2D video engine. Reportedly, it could be enough to convince Netflix and other rights holders that the PC is now sufficiently secure for premium 4K content streaming. For sure, Intel has confirmed that Kaby Lake will be certified for Sony's 4K movie and television streaming service, known as Ultra, sometime in 2017. So, fingers crossed.

Another aspect of Kaby Lake that could make having a 4K monitor worthwhile again relates to that new 2D video engine. It has full fixed-function hardware acceleration support for the most important 4K video codecs—HEVC 10 and Google's VP9. The upshot is that a Kaby Lake chip can decode eight 4K streams in parallel. In other words, pairing a Kaby Lake thin-and-light laptop with an external 4K monitor is a goer in terms of 4K video. For games, not so much. But all in good time. ⏻

The future of 4K is streaming, and with Kaby Lake, our PCs are back in the mix again.

TAKE FULL CONTROL OF ALL YOUR APPS

Take control of your apps and you take control of your PC. *Alex Cox* explains all you need to know about managing your installed content

Applications—programs you run on your PC—are a constant. They're always there. We all use them, and our machines would be dusty husks without them. But they do have a tendency to get a bit out of control, particularly if a system has existed for a long time. An application almost always consists of a bunch of files; the more apps and games you have installed, the more files exist on your hard drive. This isn't, in itself, a problem, until your drive is filled with ten thousand chunks of goodness-knows-what, and a single search operation takes half an hour because Windows has decided it must meticulously inspect every single thing. And here's a quiz for you: What was the last program you installed, and where is it on your hard drive? We'd wager that, in the first count, you're probably not sure, and in the second, you hammered through the process, let it ensconce itself in goodness-knows-what folder, and have absolutely no idea what other things it scattered over your hard disk.

Going with the flow of program installation is normal and entirely understandable, but it's not difficult or onerous to get yourself organized, and a well-sorted PC will stand you in good stead for continued use. Unless you use extreme methods, you won't ever be able to stop the miasma of random files seeping through your PC. But we'll show you how to seek them out, and how to remove unwanted programs entirely. We'll even show you new ways of installing software that make it easier to manage, update, and uninstall when you're ready. And if the thought of installing software is giving you some form of filesystem OCD, we can teach you how to make your own portable apps that don't need installing in the first place, or how to integrate your favorite apps into a custom build of Windows 10 that starts a clean PC exactly the way you want it.

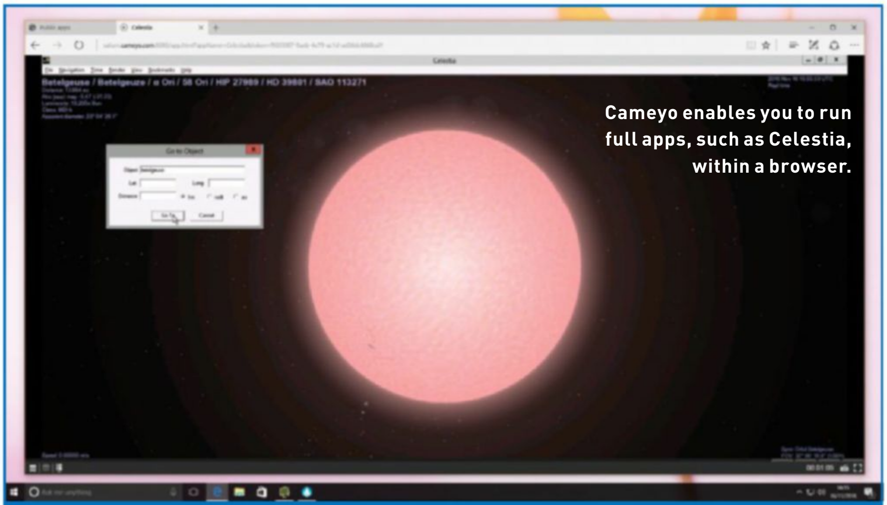
WHAT IS INSTALLING?

Once upon a time—and we're going back some 20 years here—getting a program up and running involved little more than placing a few files in a folder on your PC. That's all an installer did. Don't have the right drivers? Tough luck. Find them yourself. Operating system not up to scratch? Go through all the hassle first, and you'll find out that something's wrong when you try to run your application. A dark time, but one with benefits: Removing a program folder meant, usually, erasing all trace of that software. A simple scheme from a time when, however bleak things might have been, operating systems were less complex, and software depended on little.

Try manually excising a bit of software now, and you'll not have a good time; the typical modern installer is responsible for more tasks, and spreads the software much wider, and uninstallers are required to scrape off the remains of redundant apps. The installer decompresses large files, which have been archived to ensure an efficient distribution size. It determines whether you're installing from scratch or upgrading. It places references to program variables in the Windows registry, and configures other files to suit your hardware and personal preferences. It downloads, or upgrades, software dependencies—drivers and software frameworks that the program being installed may depend upon to run. And it does even more besides.

To make things even more complex, there's not one kind of installation package, though this won't make a huge difference to the average user. You most regularly come across executables (exe files), which tend to use some kind of third-party program to get the job done, or Microsoft Installer (msi) files, which do the same thing using Windows' built-in installation components. Others—the likes of .cub, .msp, and .msm—also use the Windows Installer, and are meant for patching or modifying components. You don't see them often while using Windows on the desktop, if at all, although those who stray into server territory might get more familiar.

For all we've said, a complex installation method isn't strictly required for every app. Many apps have been designed to run in a so-called "portable" configuration, where their content is contained in a single folder and requires no installation whatsoever. While these are few and far between—portable apps are usually small tools, although programs such as LibreOffice are also available in a non-installed format—they're perfect if you want to carry around a toolkit of apps on a USB stick. And you can

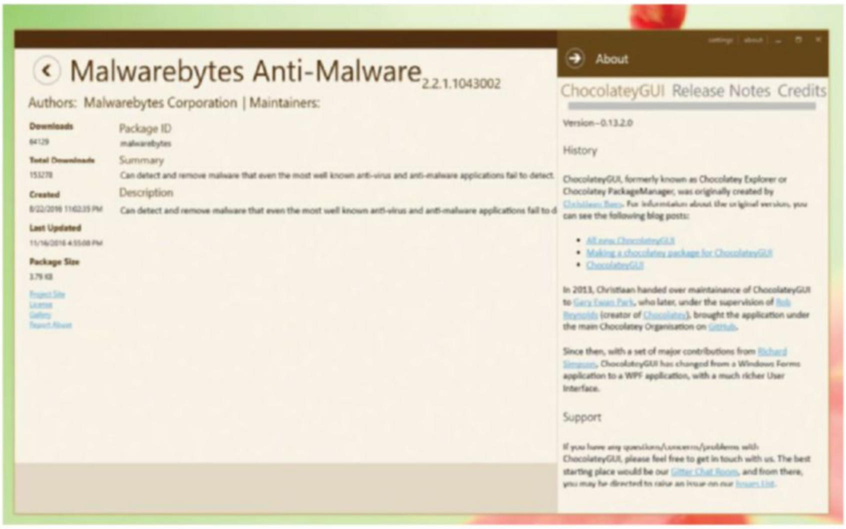


Cameyo enables you to run full apps, such as Celestia, within a browser.

CREATE PORTABLE APPS

Installing isn't the be all and end all of software. Check out http://portableapps.com—you'll find a vast range of apps that run comfortably from a USB stick without marking your precious PC even slightly. But what if your favorite app doesn't offer a portable version? Most programs can be made portable using Cameyo (www.cameyo.com), a system that uses the concept of a virtual machine to package up all the components of an application into a single executable file, either on your desktop or, excellently, online. We're not done with installers entirely, however; in order to create a Cameyo package, you need to fire it up, run the installer, and tell it when the installation has finished. It detects the changes made to the filesystem, and swallows them into its own virtual environment. When you then run the app, it finds the files exactly where it expects them to be, not even knowing that it's running in virtual space.

Cameyo's commitment to portability extends beyond USB sticks full of apps, though. You can run your stuff entirely online with its cloud hosting service (session time is limited if you're a free user), or take advantage of its library of portable apps, all of which are ready to go in its online repository. This is especially useful if you're using a managed PC—at work, for example—where you might be denied access to software you need. Register yourself a Cameyo account, head to the site, and (as long as your network administrator isn't wise to it) you gain virtual access to some of the best free apps out there. Nothing to install, no trace left behind. It's like you were never there at all.



Malwarebytes Anti-Malware 2.2.1.1043002

Authors: Malwarebytes Corporation | Maintainers:

Downloads
64129
Total Downloads
153278
Created
8/22/2016 11:02:35 PM
Last Updated
11/16/2016 4:55:08 PM
Package Size
3.79 KB

Project Site
License
Gallery
Report Abuse

Package ID
malwarebytes
Summary
Can detect and remove malware that even the most well known anti-virus and anti-malware applications fail to detect.
Description
Can detect and remove malware that even the most well known anti-virus and anti-malware applications fail to d

Version–0.13.2.0

History

ChocolateyGUI, formerly known as Chocolatey Explorer or Chocolatey PackageManager, was originally created by Christiaan Baes. For information about the original version, you can see the following blog posts:

- All new ChocolateyGUI
- Making a chocolatey package for ChocolateyGUI
- ChocolateyGUI

In 2013, Christiaan handed over maintainance of ChocolateyGUI to Gary Ewan Park, who later, under the supervision of Rob Reynolds (creator of Chocolatey), brought the application under the main Chocolatey Organisation on GitHub.

Since then, with a set of major contributions from Richard Simpson, ChocolateyGUI has changed from a Windows Forms application to a WPF application, with a much richer User Interface.

Support

If you have any questions/concerns/problems with ChocolateyGUI, please feel free to get in touch with us. The best starting place would be our Gitter Chat Room, and from there, you may be directed to raise an issue on our Issues List.

Need a quick and easy way of downloading and installing? Try ChocolateyGUI.

even make your own, in a roundabout way; see "Create Portable Apps" (pg. 37).

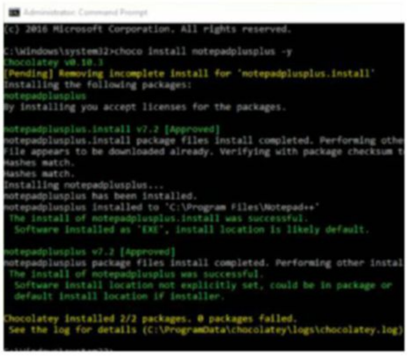
We have no doubt that you've installed programs before. Taking you through the ins and outs of clicking "Next" a few times in the course of a traditional software installation would be insulting your intelligence. But, as you may have guessed by the extent of this feature, the standard way is not the only way of going about things. The regular way, perhaps, but not the best in all cases.

You may, for example, have grabbed some of the rare decent software from the Windows Store, Microsoft's poorly-policed den of application iniquity. Whatever your feelings on its content, it has a number of advantages—Windows Store apps run in a sandboxed mode, isolated from the main OS, which means that even if something malicious slips through, it can't attack your PC directly, and installing, removing, and updating Store apps is quick and easy. The technically minded might avoid it, and there are other ways of sandboxing apps you might not know of (see "Sandboxing Applications" on pg. 41), but don't underestimate its convenience. So that's one alternative, but let's explore some of the other ways of getting software on your PC.

BATCH MANAGEMENT

Sometimes you're starting entirely from scratch with a clean Windows installation that you need to get up to speed in a hurry. Problem is, deploying a new machine can be a massive slog of a job. Collecting together the items you need is one thing, but running through the individual installation processes of all that software is time-consuming and labor-intensive, particularly if you're dealing with programs that include sneaky shovelware in their installers. One wrong click and you're infested, meaning it's not even a job you can do on autopilot. But there's a tried and tested solution that has been dealing with all that nastiness for a number of years, and it's even applicable if you're not installing a machine from scratch.

Ninite (www.ninite.com) compresses all that work into a single job, then deals with all the effort for you. It installs everything you need, preselected to your specifications, as long as it's in the extensive list of supported software, without any hassle. Head over to the site, check a few boxes for your desired apps, and click the big button to download the installer. Run it, and Ninite automatically gets hold of the latest versions of your chosen free programs—which range from security and development tools to messaging and creative apps—and installs them in the background. They all end up



```
(c) 2016 Microsoft Corporation. All rights reserved.

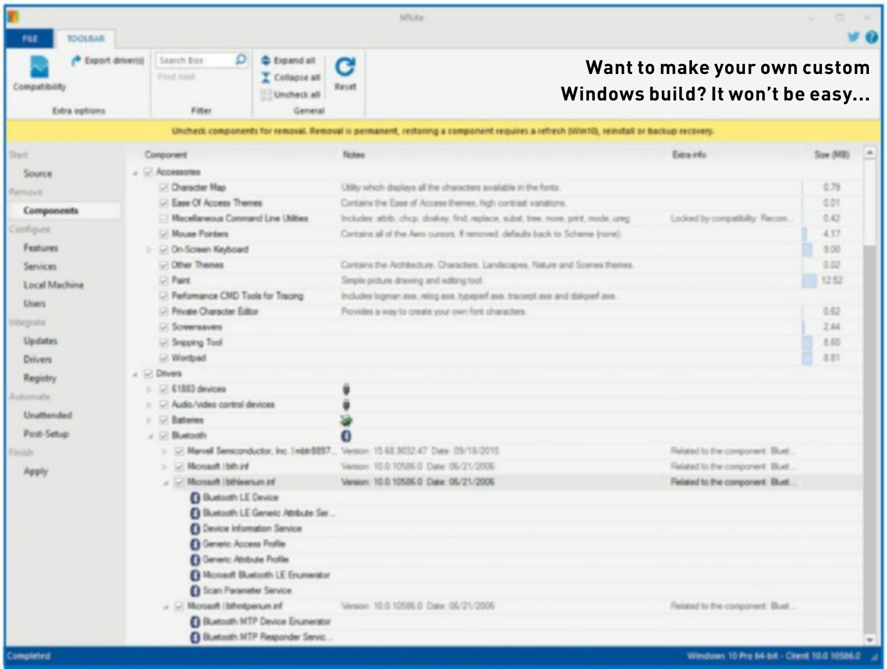
C:\Windows\system32>choco install notepadplusplus -y
Chocolatey v0.10.3
[Pending] Removing incomplete install for 'notepadplusplus.install'
Installing the following packages:
notepadplusplus
By installing you accept licenses for the packages.

notepadplusplus.install v7.2 [Approved]
notepadplusplus.install package files install completed. Performing othe
File appears to be downloaded already. Verifying with package checksum t
Hashes match.
Hashes match.
Installing notepadplusplus...
notepadplusplus has been installed.
notepadplusplus installed to 'C:\Program Files\Notepad++'
 The install of notepadplusplus.install was successful.
  Software installed as 'EXE', install location is likely default.

notepadplusplus v7.2 [Approved]
notepadplusplus package files install completed. Performing other instal
 The install of notepadplusplus was successful.
  Software install location not explicitly set, could be in package or
  default install location if installer.

Chocolatey installed 2/2 packages. 0 packages failed.
 See the log for details (C:\ProgramData\chocolatey\logs\chocolatey.log)
```

Chocolatey's command-line goodness tastes great.

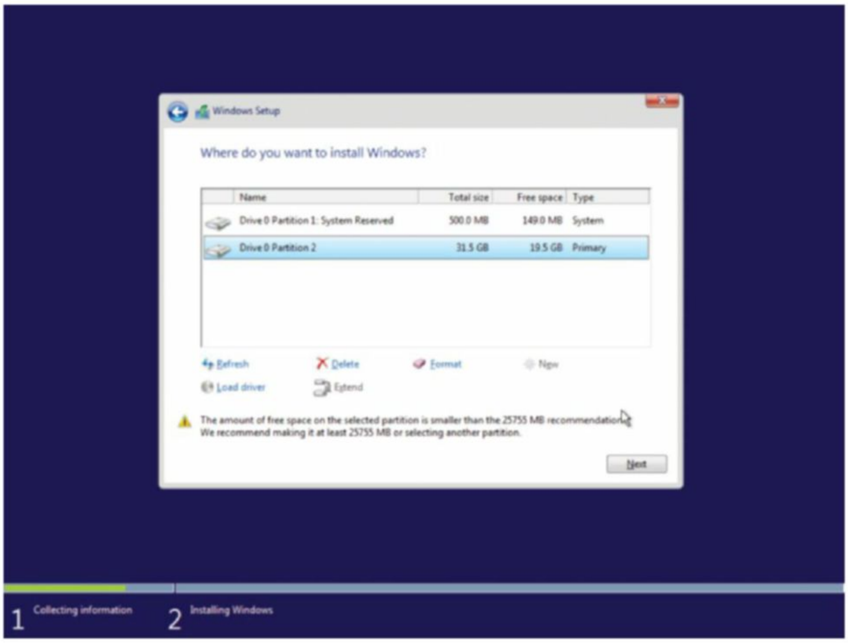


Want to make your own custom Windows build? It won't be easy...

CUSTOM WINDOWS INSTALL

Installing Windows from scratch, particularly if you're doing it repeatedly, is an absolute pain. Although we've talked about ways of installing batches of software at one time in the main feature, that's not your only option. If you're deploying a batch of machines, you could do it using a system image—essentially a fully installed version of Windows, with all the software you're going to need, that you copy wholesale on to a new hard drive. Microsoft provides a tool called the Windows Assessment and Deployment Kit to help with this task, which includes ImageX, an application that can deal with the creation and deployment of system images. Find out more and download the Windows ADK at https://developer.microsoft.com/en-us/windows/hardware/windows-assessment-deployment-kit, and make sure you run Sysprep (included with Windows) before making your image, to strip out everything machine-specific, including Windows license keys.

This is all rather complex and, frankly, quite redundant for most users. You'll probably be more interested in having a customized Windows build on hand for those odd occasions when you need to reinstall your operating system. NTLite (www.ntlite.com) is the perfect choice for this; it's a tool that helps you, yes you, create a custom Windows build, integrating software updates, adding the software of your choice, and even setting it to install completely unattended. You can use it to remove Windows components, too, meaning you end up with a streamlined install, and you can automate post-installation tasks in order to avoid that tedious early-days rigmarole. The free version is absolutely adequate unless you're looking to use it for those IT manager tasks we're trying to avoid, although don't make the mistake of thinking it's a way of avoiding complexity completely. Building an NTLite Windows package is a task that requires a good few hours and a lot of coffee.



Where do you want to install Windows?

Name	Total size	Free space	Type
Drive 0 Partition 1: System Reserved	500.0 MB	149.0 MB	System
Drive 0 Partition 2	31.5 GB	19.5 GB	Primary

The amount of free space on the selected partition is smaller than the 25755 MB recommendation. We recommend making it at least 25755 MB or selecting another partition.

Partitioning your hard drive when installing Windows can be a wise move.

Whatever your feelings on its content, the Windows Store has advantages

in their default locations, and Ninite also ensures that those clandestine crapware boxes are never clicked. While you can't use it for automatic uninstallation unless you opt for the pro version ($20 a month, which also gets you the ability to perform network installs), it does support upgrading; an occasional run is all it takes to keep all of the applications on your system up to date.

PACKAGE MANAGEMENT

Although this feature is dealing with Windows, it would be a canny move to take a look at what the competition is up to. Most flavors of Linux are perfectly capable of installing software from files that have been directly downloaded—however, that's not the usual method. Linux tends to rely on a disparate group of package managers, small tools that can download, install, update, and remove software—thus dealing with both the hassle of finding it and installing anything else your machine might require to get it running.

Windows has been employing its own under-the-hood package manager for some time, a Powershell app called PackageManagement, which is a fork of open-source downloader OneGet. It is bafflingly complex—mastering it is a task for another day, although if you're intrigued enough to experiment, you can read more about it at http://bit.ly/2gstsvW. Better, we think, to start with something more user-friendly and sweet.

Chocolatey is the delicious-sounding Windows analog to Linux tools such as apt-get, yum, and pacman, and it works in much the same way. Microsoft even uses its framework (which spawned from open-source app NuGet, just to add to the complexity of the software management family tree) as part of PackageManagement, which is a ringing endorsement. To get the command-line version installed, open up an administrative command prompt by holding Shift, right-clicking the "Start" button, and selecting "Command Prompt (admin)." Head over to www.chocolatey.org/install, then copy and paste the top install line into your command prompt. Let it run for a while, then close and reopen the window once the C:> prompt reappears.

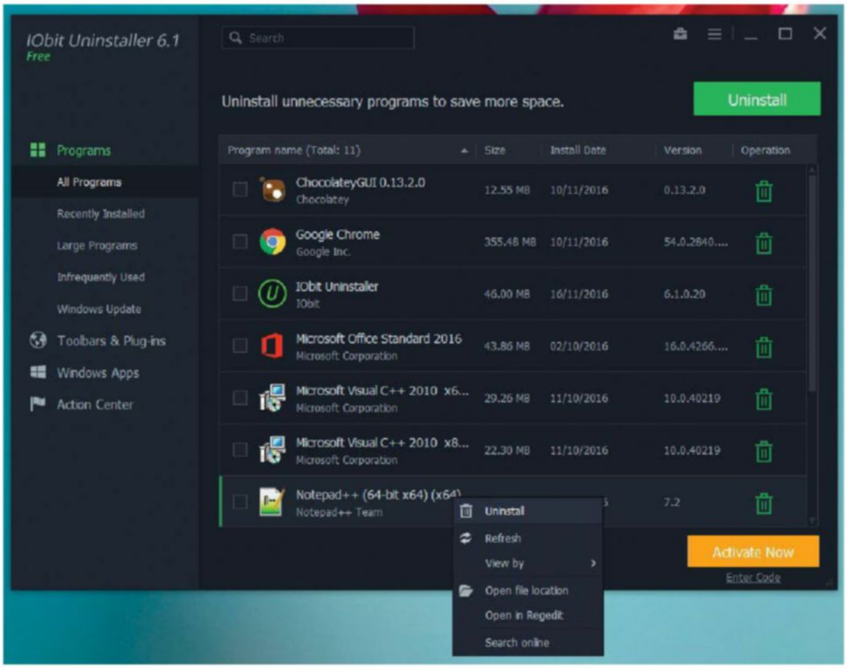
The first thing to try is, we have to admit, a little recursive. Try typing:

```
choco upgrade chocolatey
```

into a fresh command prompt, and you'll see Chocolatey's interface in action as it heads off to see whether there's a new version of itself available. There won't be, of course, because we've just installed it. But if there were, it would download and perform the upgrade autonomously. Let's get hold of something a little more useful now:

```
choco install notepadplusplus -y
```

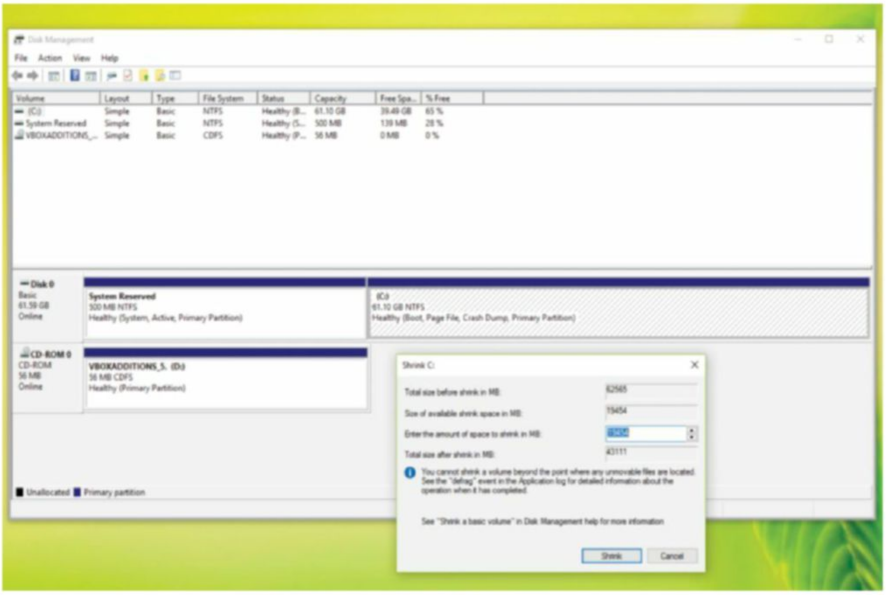
grabs excellent text editor Notepad++ from the Internet, and safely ensconces it on your system, forgoing any standard Windows installer. The "-y" part on the end of that command means you tacitly accept any confirmations that might come up during the install, so it happens in an automated manner. Replace "install" with "upgrade" or "uninstall" to perform those tasks, and check out the Chocolatey docs at www.chocolatey.org to find out more—there's



Uninstall unnecessary programs to save more space.

Program name (Total: 11)	Size	Install Date	Version	Operation
ChocolateyGUI 0.13.2.0 Chocolatey	12.55 MB	10/11/2016	0.13.2.0	
Google Chrome Google Inc.	355.48 MB	10/11/2016	54.0.2840....	
IObit Uninstaller IObit	46.00 MB	16/11/2016	6.1.0.20	
Microsoft Office Standard 2016 Microsoft Corporation	43.86 MB	02/10/2016	16.0.4266....	
Microsoft Visual C++ 2010 x6... Microsoft Corporation	29.26 MB	11/10/2016	10.0.40219	
Microsoft Visual C++ 2010 x8... Microsoft Corporation	22.30 MB	11/10/2016	10.0.40219	
Notepad++ (64-bit x64) (x64) Notepad++ Team			7.2	

Uninstalling is easy—and comprehensive—with IOBit's tool.



Volume	Layout	Type	File System	Status	Capacity	Free Spa...	% Free
(C:)	Simple	Basic	NTFS	Healthy (B...	61.10 GB	39.49 GB	65 %
System Reserved	Simple	Basic	NTFS	Healthy (S...	500 MB	139 MB	28 %
VBOXADDITIONS_...	Simple	Basic	CDFS	Healthy (P...	56 MB	0 MB	0 %

Disk 0
Basic
61.59 GB
Online

System Reserved
500 MB NTFS
Healthy (System, Active, Primary Partition)

(C:)
61.10 GB NTFS
Healthy (Boot, Page File, Crash Dump, Primary Partition)

CD-ROM 0
CD-ROM
56 MB
Online

VBOXADDITIONS_5. (D:)
56 MB CDFS
Healthy (Primary Partition)

Shrink C:

Total size before shrink in MB: 62565
Size of available shrink space in MB: 19454
Enter the amount of space to shrink in MB: [illegible]
Total size after shrink in MB: 43111

You cannot shrink a volume beyond the point where any unmovable files are located. See the "defrag" event in the Application log for detailed information about the operation when it has completed.

See "Shrink a basic volume" in Disk Management help for more information

Windows' Disk Management tool can split up any drive.

a huge number of ways to use it via the command line.

You may be more comfortable with a graphical version, however; use Chocolatey to install the package chocolateygui, and, once it's complete, you'll find it in your Start menu as usual. It's an easy interface through which you can manage the packages that you've installed on your system, and clicking the "Chocolatey" tab on the left leads you to the other applications you could have Chocolatey manage for you. The next time you need a piece of software, head to Chocolatey, type the name of the app in its search bar, and we'd wager it'll be there.

SPACE MANAGEMENT

We're spoiled by today's enormous spinning drives and ever-growing SSDs. Space doesn't tend to be an issue. But managing it really should be, both in terms of what's there and where you're putting it. Yes, Windows search can dig things up quite readily, but despite Microsoft's attempts to improve it, searching on NTFS drives is simply not a quick task. However, if your files are well, er, filed, you may never need to do a Windows search again.

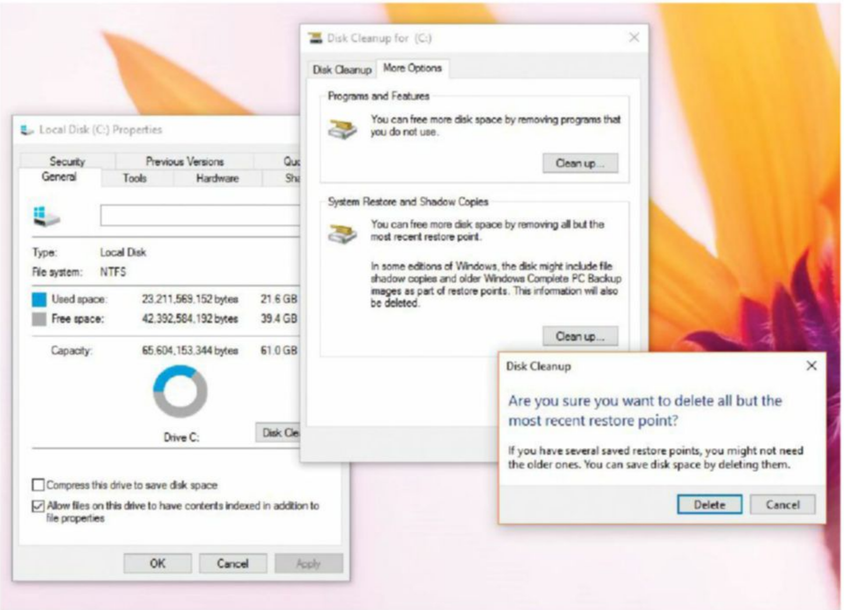
Consider, before you do anything rash, changing your default installation directory. By default, most applications you install either nestle in the "Program Files" or "Program Files (x86)" folders, splitting them up between those that run natively in 64-bit (the former) and those that don't. Logically, this makes sense; practically, 64-bit Windows is now the mainstream, 32-bit applications are entirely compatible with 64-bit systems, and there's no reason to split them apart in this way. It's just confusing. But during each program installation (bar those of poorly-coded programs that rely on specific directories to run), you are given a choice as to where you install your software. Setting up your own folder structure—say, a "Programs" folder, with folders within labeled "Music," "Office," et al—is a great way both to neaten up your collection and find out what you have installed when the Start menu begins to get a bit unruly. It's a five-minute manual job that will make life easier in the future.

Desktop Windows isn't nice enough to offer folder quotas for files in the same way its server-focused skew does. Quotas, as you might expect, help control the amount that users are allowed to store. Restricting yourself in this manner is a great way to make sure you're cleaning out the dead wood regularly—if you're forced to make room every time you want to stick a new game or program on your system, those tough decisions suddenly get much easier to make. As we've said, Windows doesn't naturally support such storage handcuffs, but we can get around it with a little cunning and a lot of partitioning.

Drive space doesn't tend to be an issue. But managing it really should be

CHOPPING AND CHANGING

By splitting your drive up into several chunks, you can effectively organize your content and stifle the amount of it that you allow yourself to hang on to. Why not give yourself a virtual D: drive for your programs, an E: drive for photos, a Q: drive for videos, and so on? There are secondary benefits: You can quickly defragment your OS partition without worrying about the rest of your drives; certain malware only affects a single partition, leaving the rest of your data safe; and formatting your Windows partition



Local Disk (C:) Properties

Type: Local Disk
File system: NTFS
Used space: 23,211,569,152 bytes 21.6 GB
Free space: 42,392,584,192 bytes 39.4 GB
Capacity: 65,604,153,344 bytes 61.0 GB

☐ Compress this drive to save disk space
☑ Allow files on this drive to have contents indexed in addition to file properties

Disk Cleanup for (C:)

Programs and Features
You can free more disk space by removing programs that you do not use.

System Restore and Shadow Copies
You can free more disk space by removing all but the most recent restore point.

In some editions of Windows, the disk might include file shadow copies and older Windows Complete PC Backup images as part of restore points. This information will also be deleted.

Disk Cleanup

Are you sure you want to delete all but the most recent restore point?

If you have several saved restore points, you might not need the older ones. You can save disk space by deleting them.

Windows' Restore Points can quickly build up. Trash the old ones.

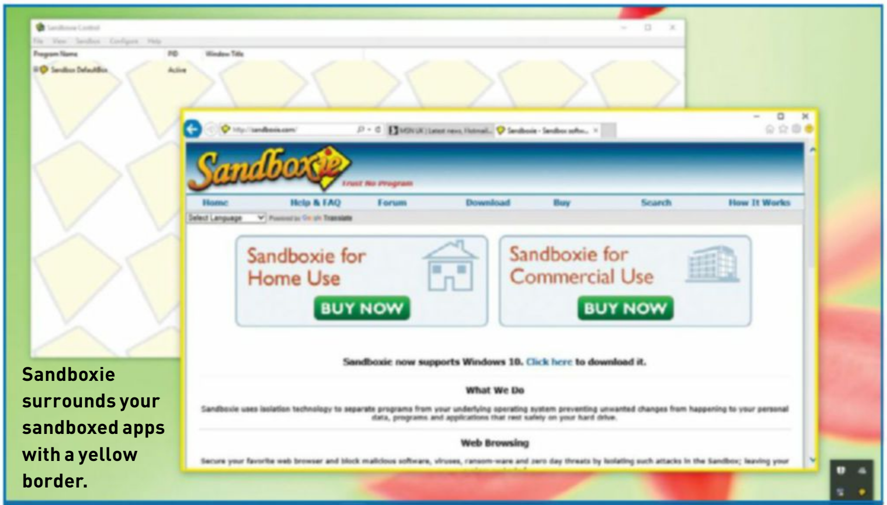
to fully reinstall doesn't mean a loss of your files. That said, as we've expounded upon, your installed programs are unlikely to work properly, thanks to the required references that get scattered through Windows whether you like it or not. Copying files between partitions is also slower on spinning platter drives, due to the physical distance the read/write head needs to travel between the split areas of space.

You might think partitioning is something that can only be done to a clean system. That certainly is the easiest way to make it happen. As you run through the Windows installer, early on (if you don't choose the "Upgrade" option) you're given the option of where to install Windows, at which point you can also chop your disk up, and format it as you see fit. We'd leave at least 32GB for Windows itself—if you're running an SSD and a magnetic drive in parallel, use the SSD for the operating system. Doing it this early is beneficial both in terms of instilling an ethos of organization to your system, and for speed—Windows won't need to shuffle itself around or be defragmented to make space for a new partition.

POST PARTITIONING

It's likely, though, that you're not going into this from scratch. And that's OK; Windows' own Disk Management tool (right-click the "Start" button, and select "Disk Management") is all too happy to slice up the drives of any living system. Open it up, and you may see that what you thought was a simple drive actually consists of several partitions; we tried it on a laptop we had hanging around—one that had seen itself upgraded from Windows 8 to 8.1 to Windows 10 to the Anniversary Update—and found a host of recovery partitions and other empty space. It might be tempting, seeing this, to ditch this wasted space, but without knowing exactly what's on each partition, we advise that you tread very carefully.

Find your main partition, or a partition you want to split, in the graphical representation. Right-click it, and select "Shrink partition" to begin the operation of creating some empty space. It's here that you'll see just how much you're allowed to shift; so-called "unmoveable" files put a damper on this in a hurry, but this problem can often be sorted by (temporarily) disabling System Restore or running Disk Cleanup. You can shrink your main partition down to the individual megabyte, but be sure to leave a reasonable amount of space free on your Windows partition in order that it can accommodate system updates and



Sandboxie now supports Windows 10. Click here to download it.

Sandboxie uses isolation technology to separate programs from your underlying operating system preventing unwanted changes from happening to your personal data, programs and applications that rest safely on your hard drive.

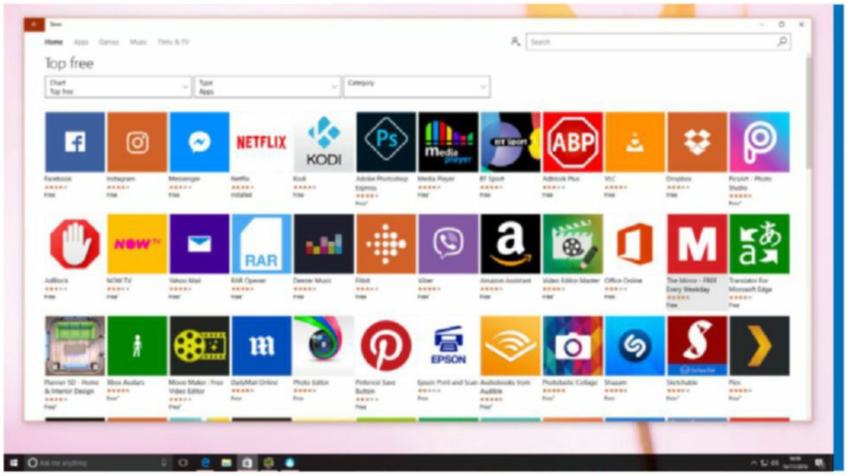
Secure your favorite web browser and block malicious software, viruses, ransom-ware and zero day threats by isolating such attacks in the Sandbox; leaving your

Sandboxie surrounds your sandboxed apps with a yellow border.

SANDBOXING APPLICATIONS

The Windows Store is clever. It shuts its apps away in their own little capsules, protecting your computer from rogues, and from the influence of anything untoward that may be swimming around your OS. Most standard Windows apps, though, don't have this facility. Unless, that is, you add it yourself. Sandboxie (www.sandboxie.com) does exactly this. If you've grabbed something a bit sketchy and need to test it out without risk, you can install it within a sandbox to ensure it doesn't get its tentacles in. Running a web browser on a family PC? Run it via Sandboxie to prevent your kids from downloading awful PC gremlins, or to stop your mom from inadvertently "upgrading" something she shouldn't. Nefarious threats such as CryptoLocker are completely negated by running a sandboxed browser, unless your mother somehow works out how to store her important documents within the sandboxed folder structure—that's behavior you need to curb on your own, though. Once you've set it up, you can open your sandboxes (through the app) as standard folders using Explorer.

Sandboxie can be used for free, though you get a nag screen after 30 days, and miss out on a few features only available to subscribers—if it's something you use regularly, you can sign up for $20.95 per year. There's a secondary benefit to all this, too: Sandboxie tucks all of the data from a program away in a single contiguous chunk of hard drive space, meaning deleting a sandboxed app doesn't leave the same fragmented storage you might get after uninstalling a regular program. It's a very minor thing, and there's every chance you're not even slightly worried by the behind-the-scenes goings-on of your data, but a well-organized drive is a fast drive.



Windows Store apps are safe and easy to work with, if not, necessarily, very good.

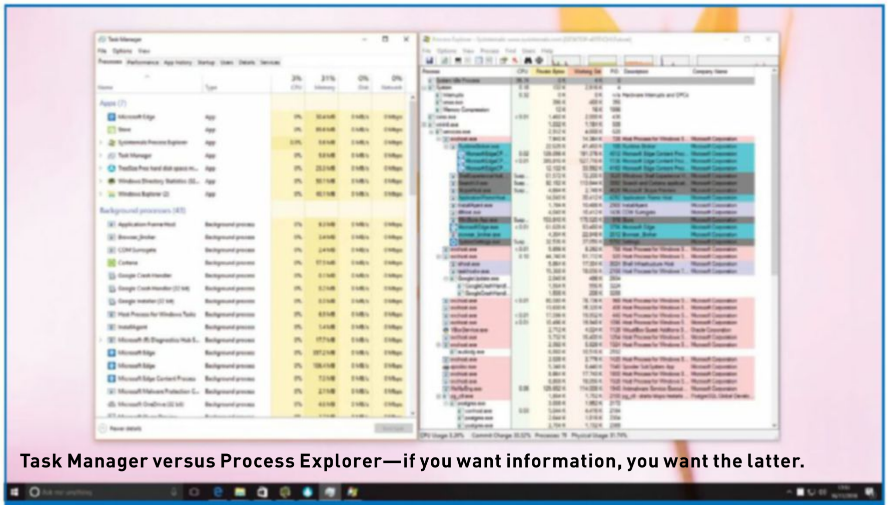
virtual memory. Once the shrink operation is complete, create your new partition or partitions by right-clicking the now unallocated empty space, selecting "New simple volume," and allocating your desired amount of space, repeating the process for each new partition you wish to create.

CLEANING UP

Where, oh where does the space go? An established system tends to eat up hard drive bytes somewhat mysteriously, and if you're obsessive about watching your drive stats, you may be wondering what's going on. We can't tell you precisely, although there are a few obvious culprits to look for if you're getting too low for that big app install. First, and most prevalent, is System Restore points. These have the potential to be huge on their own, but if you're doing frequent installs, your Windows system may be making loads of them, and keeping a needless archive. Disk Cleanup helps you delete all but the most recent. To find the option, open up an Explorer window, right-click your OS partition (or just your C: drive), select "Properties → Disk Cleanup → Clean Up System Files," then head to the "More Options" tab. Disk Cleanup can also clean up temporary files and the like, although you may not save a vast amount of space this way.

So where are the hogs? The best way to find out is to use a visual method, rather than poking through Windows Explorer poring over file sizes. For this you have two primary choices: TreeSize Free (www.jam-software.com/treesize_free) and WinDirStat (http://windirstat.net). TreeSize feels very much like a natural extension of Windows Explorer. Install it, and it runs from a context menu; right-click a folder or drive, fire it up, and it very quickly trawls through, and finds out exactly what's inside, offering you the option of reopening as an administrator if any of your files are locked down. It then lists your folders by their size, with a handy bar graph indicator in the background. Drill down into the largest folders, and you'll find your files—you can right-click them for a standard Explorer context menu, but be careful not to delete anything you don't explicitly know the meaning of.

WinDirStat is a similar tool, but infinitely cooler in that it ramps up the visual finery to a huge extent. Give it a run, select your drive (or "All local drives" if you want to be unnecessarily thorough), then wait as it laboriously traverses your disk in search of meaty files—it's certainly nowhere


Task Manager
Processes
Apps (7)
Background processes (45)
Microsoft Edge
Ask me anything

Task Manager versus Process Explorer—if you want information, you want the latter.

FINDING RESOURCE HOGS

Although we've mainly had our eyes set firmly on your hard drive in this feature, your applications don't just take up space there. Certain programs can have a disastrous negative effect on the overall running of your system, and might even be running on your system without your knowledge. Task Manager can do a pretty good job of showing you what's going on; hit Ctrl-Shift-Esc to open it, then "More Details" to see a categorized list. Right-click the column headers, select "Type," then click it to sort the apps in the list, and have a look through to see what's running. Keep an eye out for things that hog your CPU, memory, and disk access, and look at the "Performance" tab for a graph of the usage of these elements over time. The "Details" tab can offer a bit more insight into exactly what everything in the "Processes" tab is actually supposed to do. Do a full reboot of your system, reopen Task Manager, and have a good look at what's running for anything you wouldn't expect to be there had you not opened it yourself. In all likelihood, it's there because of some autorunning application, so head to the "Start-up" tab, and disable any items you don't feel you need. This can often make programs load a little slower—they have to load these components at run time, instead of them being ready when you boot your PC, but they can always be enabled again at a later time if you notice a problem.

Spying on running software can get rather addictive, and it's fully possible to delve even deeper than the Task Manager allows. Try Process Explorer (https://technet.microsoft.com/en-us/sysinternals/processexplorer.aspx), one of the Microsoft Sysinternals tools, to see what's happening on your system in ridiculous detail.

Recently added
Sandboxie Control
Sandboxie Start Menu
Run Windows Explorer sandboxed
Expand
Most used
Get Started
Feedback Hub
Command Prompt
Maps
Pin to Start
More
Store
Suggested
Star Wars: Commander
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3D Builder
Alarms & Clock
Life at a glance
Calendar
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Microsoft Edge
Photos
Rain Showers
13°
London
Skype Preview
TuneIn Radio
Twitter
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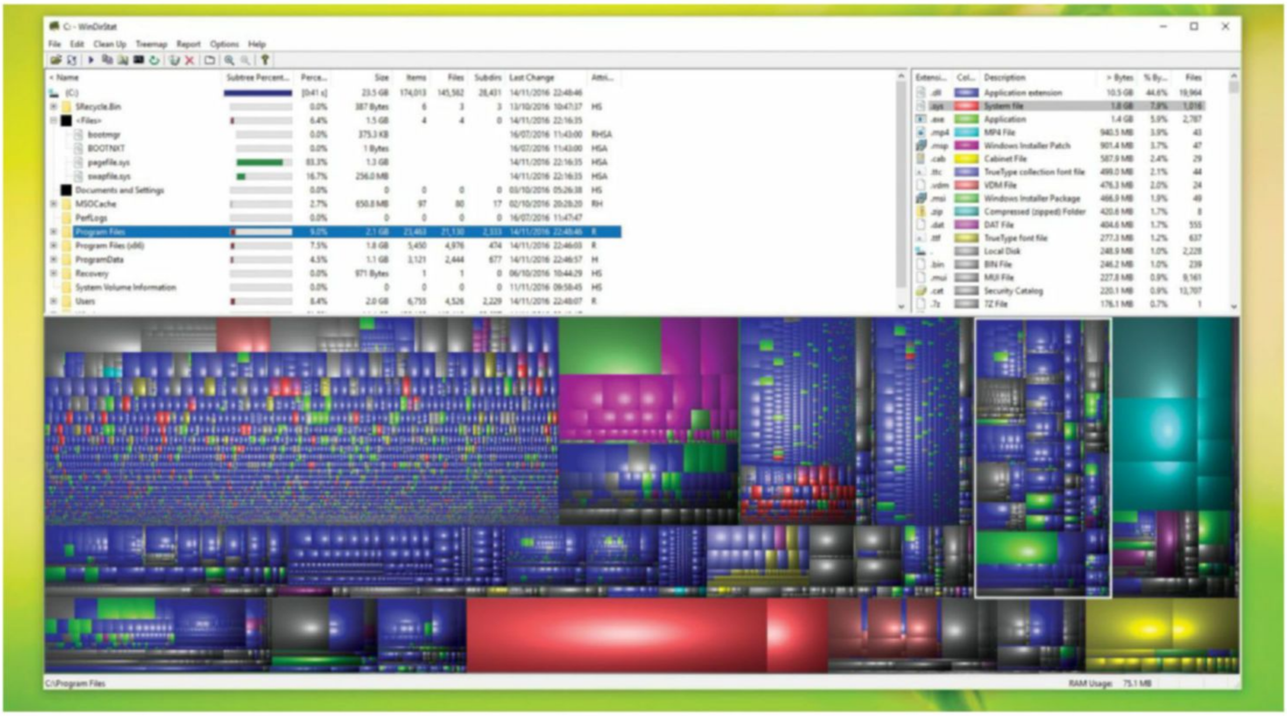
Rate and review
Share
Don't show in this list
Play and explore
More ways to play. Join us!
Xbox
Groove Music
Films & TV
NETFLIX
Microsoft Solitaire Collection
News
Get Office
OneNote
Ask me anything

Some apps just won't be uninstalled without some brute force.



WinDirStat's rectangular map is incredibly useful for finding gargantuan files.

near as fast as TreeSize. When it's done, though, you'll see the benefit: a color-coded map of your entire drive, with rectangles representing the size of files, collected into larger rectangles that represent folders. Click a big file and check the status bar to see exactly what it is, and right-click to find a context menu that will help you open the folder in Explorer or copy its path to your clipboard. Click a folder or file in the top left pane, and it highlights it in the visual view, or use the top-right pane to hunt down files of particular types. They're listed, by default, in order of the size those files take up, so it's a good way to discover the space-munching culprits.

TIME TO UNINSTALL

Once you've found the monsters—or when you're simply done with your apps—how do you remove them? You might be surprised, but we're going to suggest that the best way to clean up an old app is by using Windows' own built-in interface, which you can find in the "Programs and Features" section of the Control Panel. Removing files using this tool automatically fires up their included uninstaller (or, in the case of MSI-installed components, the Windows built-in equivalent), which should mean all trace of the app is wiped away. Make sure, if using this method, that you remember to check any boxes that also remove settings files or equivalent because, while they're not going to take up much space, any redundant files you leave on your drive slow down indexing and basically irritate you no end.

If you're a fan of overkill and salting the Windows earth, try a tool such as IOBit Uninstaller (www.iobit.com). It's available as a portable app from http://portableapps.com (because if anything should be, it's a tool that helps you get rid of installed software), and it's a great way of making sure every trace of an app is removed. Set it to work, and it bangs through your registry and filesystem to find files traditional uninstallers might have missed. If a program doesn't appear to be installed—as in, it doesn't appear in "Programs and Features"—you can also point IOBit Uninstaller at its executable file, and it does its best to do an automatic uninstall. It's not flawless, but it's pretty damn good.

SUPER REMOVAL

Uninstalling apps you've deliberately added to your PC is one thing. Hacking away the dead wood that Microsoft includes by default in Windows is another. It doesn't look easy—there's not even an obvious way to remove those horrible, redundant entries from the Windows 10 Start menu. At least, there doesn't seem to be, but there's a sneaky feature built in to Win 10: Right-click an unwanted app in the Start menu list and, if it can be easily gotten rid of, an "Uninstall" option is present in the context menu. But what of the ream of apps that can't be chopped out in this way?

For this you need Powershell, the super-command line that's bundled with Windows. Find it in the application list, right-click it, select "Run as administrator," then type the following to remove (in this example) 3D Builder:

```
Get-AppxPackage *3dbuilder* | Remove-AppxPackage
```

This uses Get-AppxPackage to seek out the appropriate program, then pipes its location and information to the Remove-AppxPackage tool; the phrase within the asterisks can be replaced with the specific package names for a host of applications, though these aren't immediately obvious, so here's the basic list:

3D Builder: *3dbuilder*
Alarms and Clock: *windowsalarms*
Calendar and Mail: *windowscommunicationsapps*
Camera: *windowscamera*
Groove Music: *zunemusic*
Maps: *windowsmaps*
Movies & TV: *zunevideo*
OneNote: *onenote*
People: *people*
Photos: *photos*
Store: *windowsstore*
Voice Recorder: *soundrecorder*
Xbox: *xboxapp*

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TECH PORN

HP Spectre

WE ADORE POWERFUL GEAR here at *Maximum PC.* But we're also suckers for sweet aesthetics. We want it all: power and looks. And for those of us not willing to go down the Apple route, the options have always been somewhat limited. Which is where HP's latest offering slides smoothly into view, showing off its tasty styling, while not being too shy about the gorgeous tech hidden within.

Measuring a faintly ridiculous 10.4mm and weighing just under 2.5lb, this is the ideal machine to throw in your bag and take out on the road with you. Of course, when we say "throw," we really mean slide lovingly into that leather briefcase you've bought to carry this gorgeous sliver of computing around with you. And with up to nine hours of battery life, it should last you your full working day, too.

There's no room for a discrete GPU in here, but the Intel HD Graphics 520 does a good job of keeping the 1080p IPS screen bathed in pixels. It's not a gaming monster, but it'll handle casual titles happily. It's great for watching movies on at the end of a hard day, too.

–ALAN DEXTER

1 SAMSUNG 512GB NVME SSD

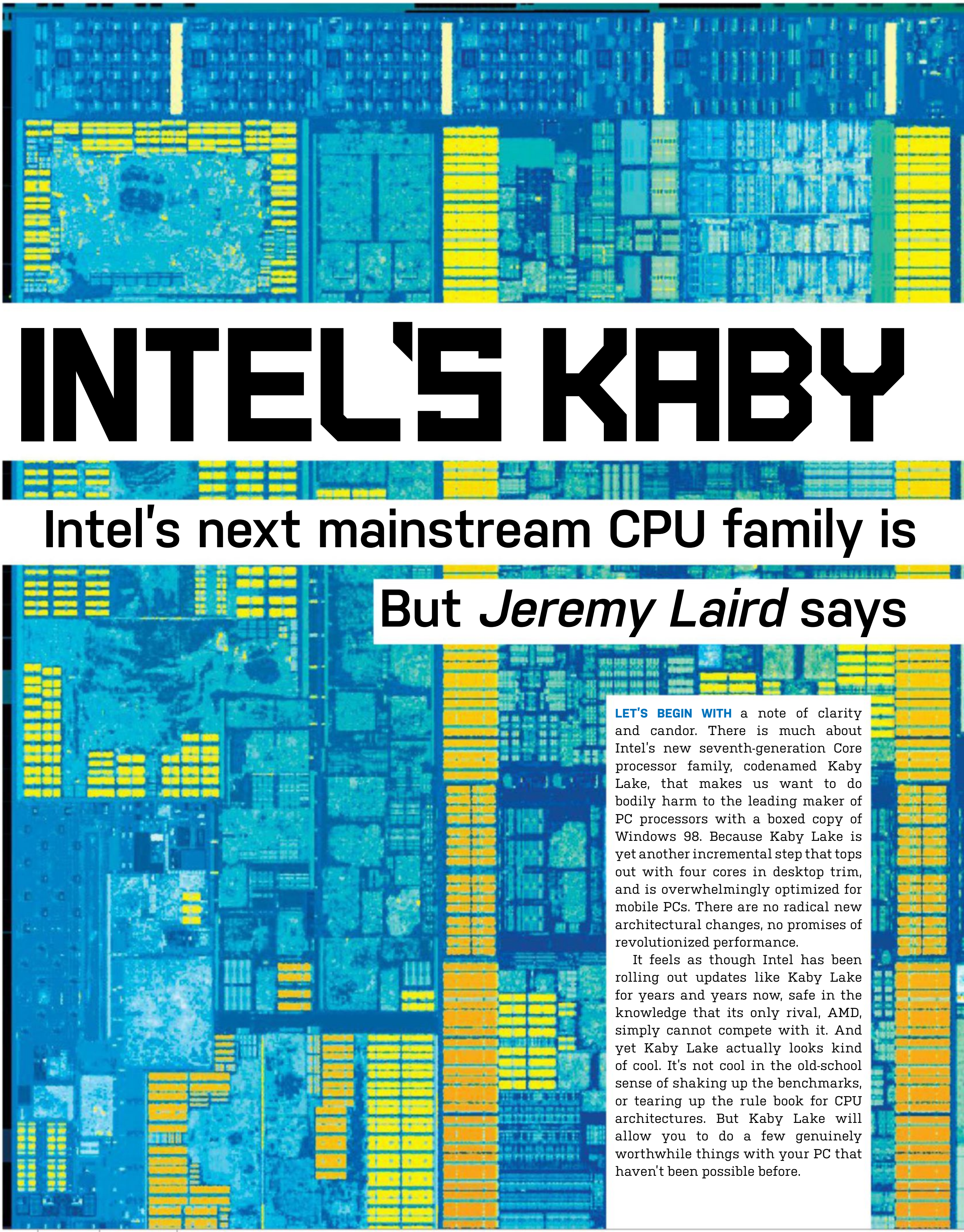
One of the beauties of M.2 SSDs is that they're tiny. Not in capacity, but physically. 512GB is more than enough for normal use, and it's fast too—in a quick bout of testing, we saw 1,664MB/s reads and 580MB/s writes.

2 INTEL CORE i7-6500U

That's right, inside this tiny machine, you'll find a Skylake Core i7 CPU running at 2.59GHz. It actually has more in common with most Core i3 chips, boasting only a pair of physical cores, but it does operate at an incredibly low TDP of just 25W, so we'll forgive Intel's marketing shenanigans on this occasion.

3 BANG & OLUFSEN AUDIO

The perfect accompaniment to the full HD screen is the luscious sound produced by the Bang & Olufsen approved sound system. There's a headphone jack around the back if you aren't in the mood to share, as well as three USB Type-C ports for connecting your goodies.



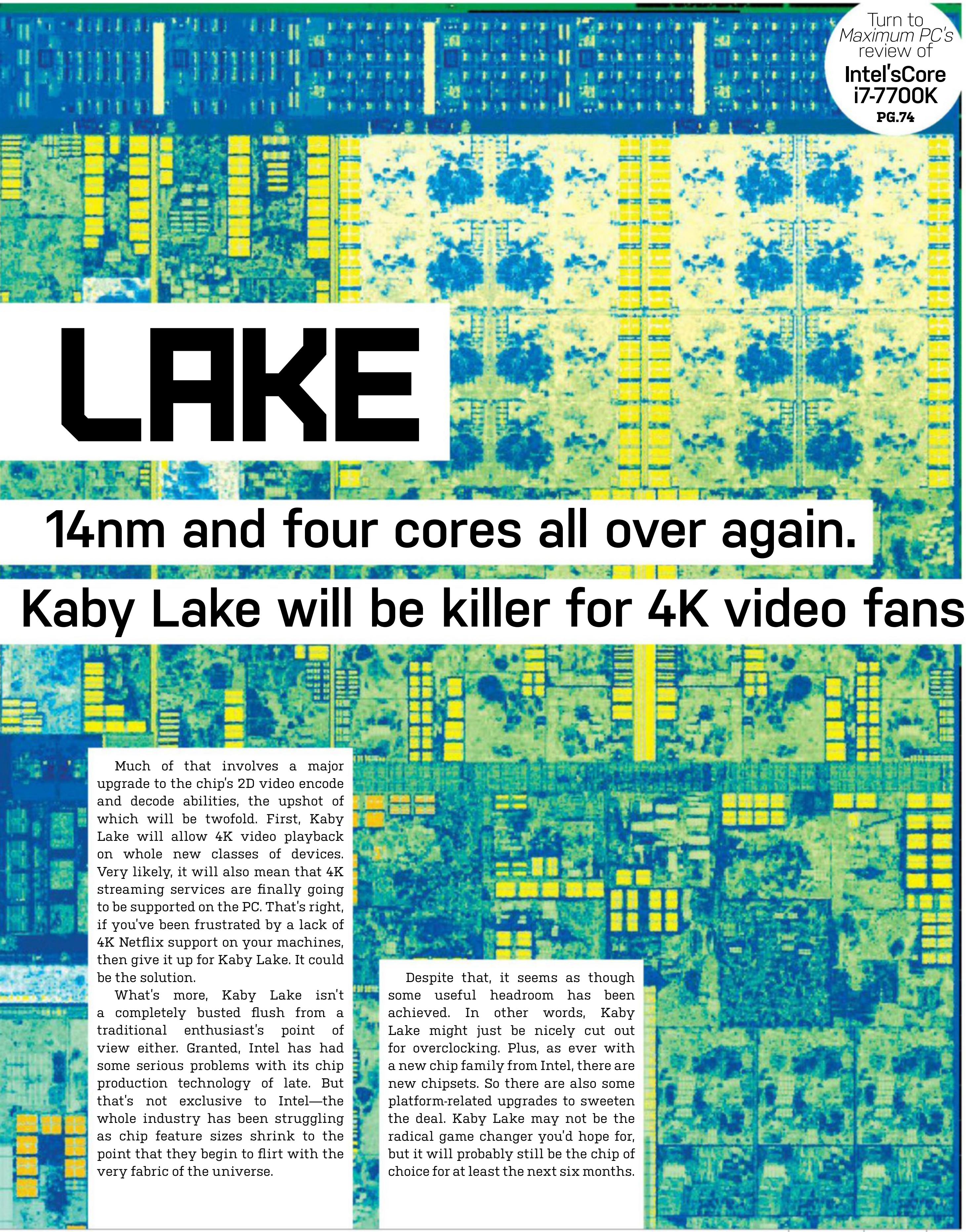
INTEL'S KABY

Intel's next mainstream CPU family is

But *Jeremy Laird* says

LET'S BEGIN WITH a note of clarity and candor. There is much about Intel's new seventh-generation Core processor family, codenamed Kaby Lake, that makes us want to do bodily harm to the leading maker of PC processors with a boxed copy of Windows 98. Because Kaby Lake is yet another incremental step that tops out with four cores in desktop trim, and is overwhelmingly optimized for mobile PCs. There are no radical new architectural changes, no promises of revolutionized performance.

It feels as though Intel has been rolling out updates like Kaby Lake for years and years now, safe in the knowledge that its only rival, AMD, simply cannot compete with it. And yet Kaby Lake actually looks kind of cool. It's not cool in the old-school sense of shaking up the benchmarks, or tearing up the rule book for CPU architectures. But Kaby Lake will allow you to do a few genuinely worthwhile things with your PC that haven't been possible before.



Turn to *Maximum PC's* review of **Intel's Core i7-7700K** **PG.74**

LAKE

14nm and four cores all over again. Kaby Lake will be killer for 4K video fans

Much of that involves a major upgrade to the chip's 2D video encode and decode abilities, the upshot of which will be twofold. First, Kaby Lake will allow 4K video playback on whole new classes of devices. Very likely, it will also mean that 4K streaming services are finally going to be supported on the PC. That's right, if you've been frustrated by a lack of 4K Netflix support on your machines, then give it up for Kaby Lake. It could be the solution.

What's more, Kaby Lake isn't a completely busted flush from a traditional enthusiast's point of view either. Granted, Intel has had some serious problems with its chip production technology of late. But that's not exclusive to Intel—the whole industry has been struggling as chip feature sizes shrink to the point that they begin to flirt with the very fabric of the universe.

Despite that, it seems as though some useful headroom has been achieved. In other words, Kaby Lake might just be nicely cut out for overclocking. Plus, as ever with a new chip family from Intel, there are new chipsets. So there are also some platform-related upgrades to sweeten the deal. Kaby Lake may not be the radical game changer you'd hope for, but it will probably still be the chip of choice for at least the next six months.

Navin Shenoy, Intel corporate vice president and general manager for its Client Computing Group, holds a seventh-gen Intel Core processor.

CREDIT: INTEL CORPORATION

KABY LAKE REPRESENTS no less than the third new processor family to be released on Intel's 14nm process. That is the critical factoid that puts Intel's latest CPU into proper context.

For starters, it's symptomatic of the problems Intel has had shrinking the transistors inside its chips down to ever smaller proportions. Prior to Kaby Lake, Intel had been running to—or at least attempting to run to—a self-imposed cadence of product launches known as "Tick-Tock." The idea was simple: One year Intel would shrink an existing processor architecture via a new manufacturing process node, the next a new architecture on the existing node. Rinse and repeat, long live Moore's Law, and so on.

Except Intel couldn't keep up. With each new node, there was a little Tick slippage, leaving several of the Tocks looking short-lived. Tick-Tock was introduced in 2007, the year Intel's first 45nm chips went on sale. Follow the logic of Tick-Tock, and the schedule should have been 32nm in 2009 (that slipped into 2010), 22nm in 2011 (didn't happen until April 2012), 14nm in 2013 (September 2014 in reality), and 10nm in 2016. 10nm obviously hasn't happened yet, and probably won't until late 2017, by which point Intel will be a full year behind its Tick-Tock schedule. Whoops.

None of which is a critique of Intel. The entire chip industry has been struggling to keep up with the two-year cadence for doubling transistor densities as famously dictated by Moore's Law. Instead, Intel's struggles are the background to a new paradigm being introduced with Kaby Lake, namely "Process, Architecture, Optimization." So that's a new production process in year one, a new architecture in year two, and an optimization of that architecture in year three. Call it Tick-Tock-Tock, if you like, but as the third 14nm processor family, Kaby Lake is an optimization under the new regime.

LAKE-SIDE LAUNCH

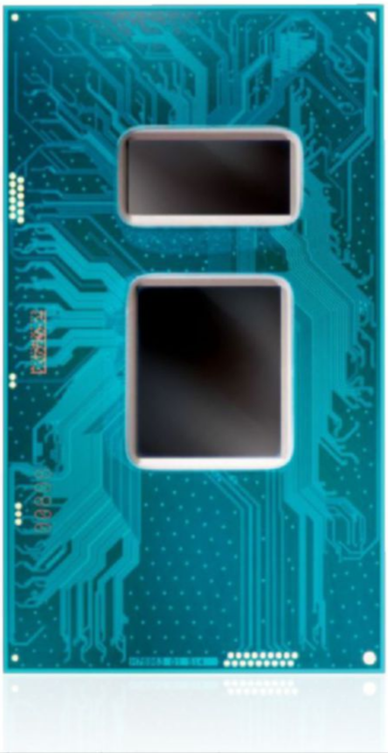
Of course, given the timing of "Process, Architecture, Optimization," it's hard not to conclude that it's a retrospective wheeze in response to troubles ramping up 14nm production. But the change of strategy helps to explain the slightly disjointed launch of the Kaby Lake family. Since August 2016, mobile PCs with Kaby Lake chips have been available, starting with the super-slim 9.8mm Acer Swift 7 Ultrabook. Today, there are plenty of Kaby Lake laptops, including the Dell XPS 13 refresh, with its stellar 22-hour battery life (which hints that Kaby Lake is pretty interesting), but no desktop chips.

Meanwhile, both Intel's multi-core server chips, with up to 22 cores, and its closely related enthusiast-class Core i7 processors for the LGA2011 platform remain based on the older Broadwell architecture, a full two generations behind the latest laptop chips.

If that's the background, what are the tech specs of the new architecture, and what CPU models can we expect when the desktop-orientated Kaby Lake-S variants arrive in early 2017? The second half of that question is straightforward. At the time of writing, Intel hasn't officially announced any desktop models, but leaked documents have revealed the launch lineup in detail.

As seventh-generation Core processors, the new chips take the 7000 Series moniker. The top chip at launch will be the quad-core, eight-thread Core i7-7700K, clocked at 4.2GHz base clock. That's 200MHz more than the existing Skylake-based Core i7-6700K. The quad-core, quad-thread Core i5-7600K, meanwhile, jumps to 3.8GHz from the 3.5GHz of its 6600K predecessor. However, it isn't known for sure what the new 7700K and 7600K will deliver in terms of Turbo clock speeds. As we'll see, there are some reasons to think these new Kaby Lake puppies will be quite the thing for overclocking.

Across the 11 new Kaby Lake processors that will be available at launch, base clock speeds are up by 100–300MHz. Once we know what the official Turbo clocks are, of course, the next question will be overclocking. As we suggested, laptops such as the Dell XPS 13 and its borderline ridiculous battery life hint at significant progress when it comes to the process technology, despite Kaby Lake remaining



Left: Intel's seventh-gen Core U-series.

Right: Intel's seventh-gen Core Y-series.

14nm. Could that play into overclocking headroom with the desktop S series?

It may make sense. That's because Intel hasn't carried over its 14nm production tech untouched for Kaby Lake. Instead, it's been revised, and is now known as 14PLUS. Two major changes are involved. Taller fins for the FinFET gates (so-called for their fin-like 3D structure) mean less driving current is needed, and thus less leakage, and, in turn, power consumption and heat dissipation are less of a problem. The other feature is a wider gate pitch, which, at first glance, is an odd one.

Gate pitch is a critical metric when determining transistor density. So, wider gate pitch would, on the face of it, mean lower transistor density, which, in turn, could be regarded as a step backward. For now, the impact of this is unclear in terms of Intel's die size and chip production costs. Intel has reportedly said that it won't have an impact on die size. What we can say is that the intended benefit is that the wider pitch allows the heat generated by each transistor to dissipate more efficiently, rather than multiplying with that of nearby transistors.

Put the wider pitch together with the taller FinFETs and, in theory, you have access to greater voltage range and higher frequencies. Certainly, base clock speeds are up over Skylake chips. Will overclocking headroom benefit, too? We hope so. There's at least a chance that Kaby Lake could be the best overclocking chip from Intel for several generations.

CLOCK-WATCHING

That's the process tech dealt with. What about architectural tweaks? Intel has said little about Kaby Lake's execution cores, other than to indicate that little has changed. You should not, therefore, expect much, if any, improvement in throughput when it comes to performance-per-clock. In other words, a 3.5GHz Kaby Lake processor will perform the same in most tasks as a 3.5GHz Skylake chip. Any improvements would need to come from higher clock speeds.

Intel hasn't changed the architecture of its 3D cores in its integrated graphics engine, either. But there is one exception to this tale of mostly static per-clock performance: 2D video. There are three ways a processor can handle 2D video. It can brute-force it on the general-purpose CPU cores. It can use the integrated 3D graphics cores to accelerate some parts of the job. Or it can hand the job over to the purpose-built or fixed-function 2D video engine for full hardware acceleration.

In practice, it's a little more complicated. Depending on the spec of a given CPU

MOBILE MAGIC

No new CPU core design. No additional CPU cores, for that matter. What is there in Kaby Lake to please desktop enthusiasts? Probable support for DRM-sensitive 4K stream services, such as Netflix, could be a major boon. We wouldn't kick the additional PCI Express lanes out of bed, either.

There's reason to think Kaby Lake might be quite the overclocking tool, too. But as a package, it's hardly the stuff of enthusiasts' dreams. As ever, then, its real appeal is likely to be as a mobile processor. Of course, mobile PCs with Kaby Lake processors have been available since the fall of 2016.

The impact of the chip's improved efficiency has been real enough. When Dell revised its popular XPS 13 laptop to add Kaby Lake chips, claimed battery life leaped to a slightly crazy 22 hours, in part due to the refinements Intel has achieved with its revised 14nm production process. But that probably doesn't truly capture what a huge game changer Kaby Lake could be for video playback in laptop and tablet PCs.

You can read about the full details of the new media engine in the main story. But the implications of full fixed-function hardware support for the latest video codecs could be profound. For starters, it will enable 4K video playback in a whole new class of devices. Existing Intel ultramobile Core processors can struggle with some 4K playback, especially when it's browser-based. But Kaby Lake's media engine can decode eight 4K streams simultaneously. Crazy.

Just as important, hardware decode will mean massively lower battery drain when cutting cables to watch 4K content. When you think about how most people use their laptops, that makes for a pretty compelling package. When you next buy a laptop PC, you're probably going to want it to come with Kaby Lake.

and the video codec, there can be some overlap, with some parts of the workload done in software, others accelerated by the 3D cores, and yet others hardware accelerated. The big news for the Kaby Lake fixed-function media engine is that Intel has added some serious full-hardware support for the latest codecs, right up to 4K resolutions.

More specifically, there's full hardware support for encode and decode of 4K HEVC Main10 profile video streams. Skylake chips can decode HEVC Main10 up to 4K at 30fps, but they use a hybrid process that shares the workload between the general-purpose CPU cores and the GPU's shader cores. The upshot of which is that Kaby Lake can decode 4K HEVC video streams at a fraction of the powerload of Skylake. In fact, the engine is so powerful, it can decode up to eight standard 4K HEVC streams simultaneously, and can support ultra-high bitrate streams, too, up to 4K at 60fps and 120Mbps, which is pretty preposterous when you think about it.

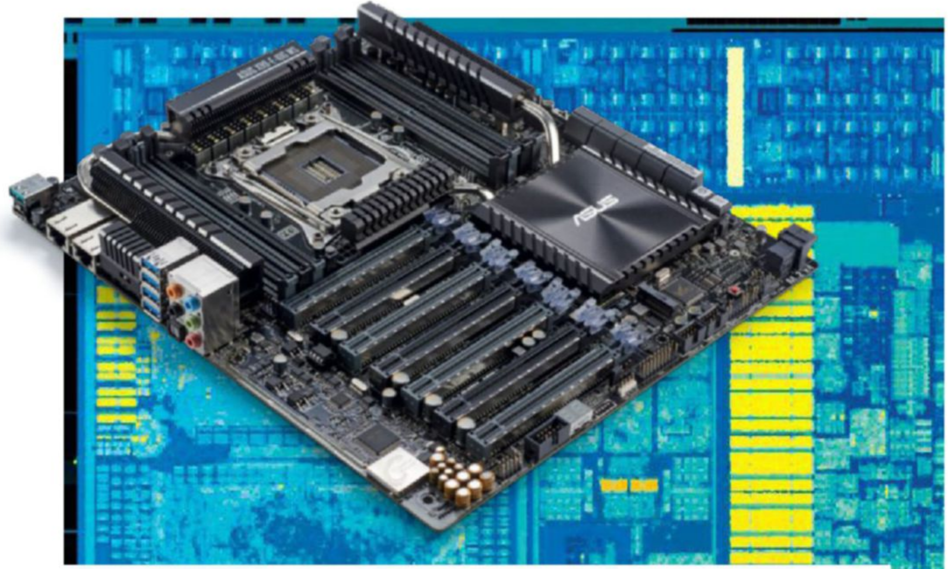
Intel has also given Kaby Lake proper fixed-function 8-bit encode and 8/10-bit decode support for Google's VP9 codec. Again, Skylake only supported that in a hybrid mode. VP9 is Google's preferred codec for high-quality video on YouTube, so full hardware support is a real boon.

THE 4K FUTURE

The really intriguing development when it comes to streaming video arguably lies elsewhere. As you probably know, Netflix doesn't allow 4K streaming to PCs. That's largely, if not exclusively, down to piracy concerns. However, Kaby Lake's video engine is thought to have additional DRM features that may allow it to be certified as a platform for 4K Netflix streaming. On a related note, Intel has confirmed that Kaby Lake will be certified for Sony's 4K movie and television streaming service sometime in 2017. It's known as ULTRA, and has hitherto been restricted to Sony's own TVs, which tends to confirm that Kaby Lake does indeed bring new DRM features to the mix.

A final related feature enabled by the new 2D video engine are some tweaks to enable HDR and wide color gamut in Rec.2020 format. Intel hasn't gone into much detail, but increased per-channel color bit widths are surely part of the package. Intel has also indicated that Kaby Lake's HDR support leverages both graphics execution units and the 2D video engine, so there is scope for hardware acceleration and assist to enable HDR visuals within a low-power profile.

That pretty much wraps up the video part of the Kaby Lake package,



WHERE ARE INTEL'S SIX-CORE MAINSTREAM CPUS?

Where the heck are Intel's mainstream six-core (or more) CPUs? Generation after generation, Intel wheels out new chips, but at best they have four cores. Enthusiasts seeking more cores have had to move to Intel's altogether more expensive enthusiast socket and platform to access more cores.

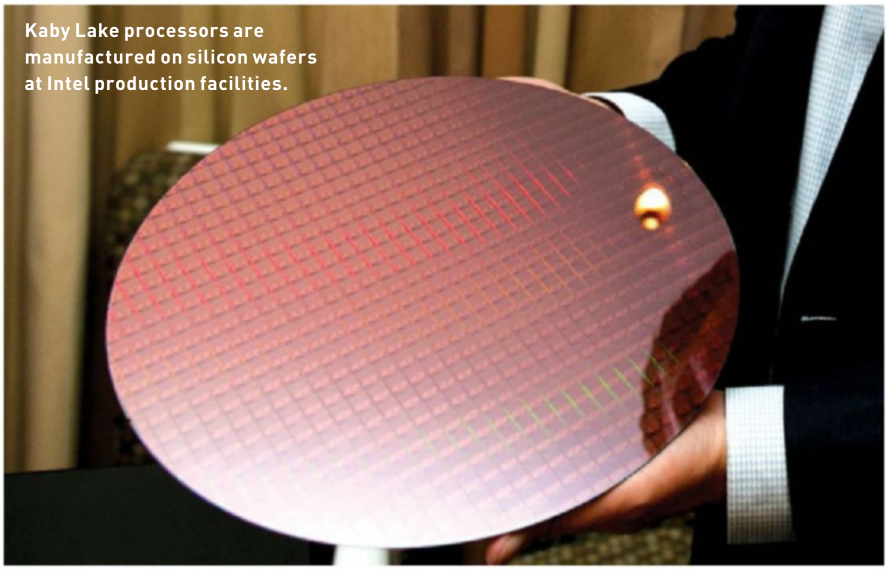
Problem is, platforms such as X99 and the LGA2011 socket are thinly disguised server technology. That means cost and complexity of entirely no relevance to desktop PCs. Far more preferable would be for Intel to chuck a few more cores into its mainstream LGA1151 socket.

Of course, some would argue that CPU performance is already good enough, that the focus for performance improvement should be elsewhere. And it's true that many applications don't require additional CPU performance—or, rather, the type of performance they could make use of pertains to a single software thread running on a single core. Adding more cores won't help.

But some applications scale well on multiple cores. Belatedly, games are beginning to fall into that category. Then there's the old "build it and they will come" philosophy. Who knows what delights coders and developers may come up with if only mainstream PCs had more performance. What's more, with AMD planning to release its new Zen CPUs in 2017, Intel may at last be forced to up its game.

Well, rumor has it that Intel is finally planning to release some mainstream CPUs with more than four cores. Spotted in various roadmaps is a new family of chips known as Coffee Lake. Details are sparse, but it's penciled in for early 2018. It's actually slated as a high-performance mobile chip. But it is listed as offering up to six cores.

Put another way, if it does slot into the LGA1151 socket (or its future mainstream equivalent), it's not hard to imagine a desktop sibling being offered. If so, there will be much rejoicing inside *Maximum PC* HQ.



Kaby Lake processors are manufactured on silicon wafers at Intel production facilities.

CREDIT: INTEL CORPORATION

so what about the minor matter of the CPU cores and general performance. Is there any good news? Apart from the aforementioned increase in clock speeds, the answer is no. Intel has introduced Speed Shift v2. That's a feature that, via a software driver, allows the CPU itself to control its own Turbo mode. This latest version allows for quicker adjustments in CPU frequency. Kaby Lake can react in 10ms to Skylake's 30ms. But this is a feature that's most relevant to mobile PCs.

All of which leaves one final frontier: the new platform that comes with Kaby Lake. We speak, of course, of the new 200 Series motherboard chipsets. As we go to press, full specifications are still being sorted out, but a number of intriguing new features are likely. For starters, the native PCI Express support goes up from 20 PCI Express 3.0 lanes on 100 Series chipsets, such as the Z170, to 24 lanes. Access to PCI Express bandwidth is becoming ever more critical as storage technology increasingly switches from SATA interfaces to PCI Express.

Specific support for Intel's upcoming Optane storage and memory technology is also in the mix. Exactly what form this will take remains to be seen. You could say the same thing for Optane, to be fair. A general affinity for high-bandwidth interfaces will feature, too. Expect support for up to 10 USB 3.0 sockets built into the PCH chip natively. Thunderbolt 3 support built natively into the platform is also expected, though this isn't quite a total, nailed-down certainty.

Of course, these features will vary depending on the CPU and spec of the motherboard chipset. The 200 Series chipsets and Kaby Lake maintain the existing LGA1151 socket. Indeed, the 200 Series chipsets are backward compatible with sixth-generation CPUs—Skylake, in other words. Needless to say, if you use a Skylake chip in a 200 Series mobo, you'll default back to the 20 PCI Express lanes built into the CPU, and native Thunderbolt 3 support will be a goner, too. Anyhow, the usual stratification of consumer chipsets will feature, with mainstream H250, H270, and Q270 chipsets capped by the more enthusiast-orientated Z270 chipset.

Kaby Lake certainly isn't the most compelling CPU Intel has ever cooked up. It won't blow away any records for pure performance. But when you factor in some of the new platform features, and the extra bandwidth available for storage and peripherals, along with the new 2D video engine, and the promise of DRM support for premium 4K streaming services, the likely upshot is that Kaby Lake will be pretty compelling for anyone building a new PC. That's not something you've always been able to say about Intel's CPU refreshes of late.

THOSE NEW KABY LAKE DESKTOP CPUS IN FULL

New Kaby Lake Model	Cores/Threads	Base Clock	Old Skylake Model	Cores/Threads	Base Clock
Core i7-7700K	4/8	4.2GHz	Core i7-6700K	4/8	4.0GHz
Core i7-7700	4/8	3.6GHz	Core i7-6700	4/8	3.4GHz
Core i7-7700T	4/8	2.9GHz	Core i7-6700T	4/8	2.8GHz
Core i5-7600K	4/4	3.8GHz	Core i5-6600K	4/4	3.5GHz
Core i5-7600	4/4	3.5GHz	Core i5-6600	4/4	3.3GHz
Core i5-7600T	4/4	2.8GHz	Core i5-6600T	4/4	2.7GHz
Core i5-7500	4/4	3.4GHz	Core i5-6500	4/4	3.2GHz
Core i5-7500T	4/4	2.7GHz	Core i5-6500T	4/4	2.5GHz
Core i5-7400	4/4	3.0GHz	Core i5-6400	4/4	2.7GHz
Core i5-7400T	4/4	2.4GHz	Core i5-6400T	4/4	2.2GHz
Core i3-7300	2/4	4.0GHz	Core i3-6300	2/4	3.8GHz
Pentium G4620	2/2	3.8GHz	Pentium G4520	2/2	3.6GHz
Pentium G3950	2/2	3.0GHz	Pentium G3920	2/2	2.9GHz

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The easy guide for Raspberry Pi users PG.32
MAKE A MINECRAFT MACHINE
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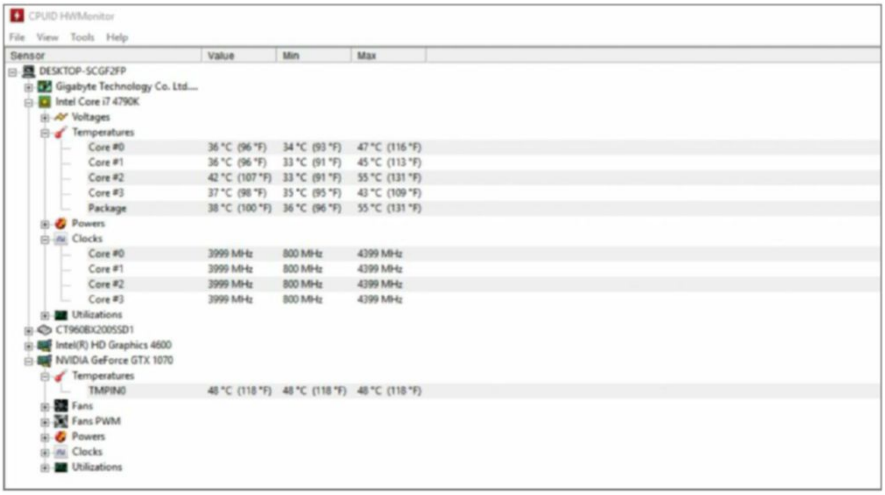
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH



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Sensor                              Value            Min             Max
DESKTOP-SCGF2FP
   Gigabyte Technology Co. Ltd....
   Intel Core i7 4790K
      Voltages
      Temperatures
         Core #0                    36 °C (96 °F)    34 °C (93 °F)   47 °C (116 °F)
         Core #1                    36 °C (96 °F)    33 °C (91 °F)   45 °C (113 °F)
         Core #2                    42 °C (107 °F)   33 °C (91 °F)   55 °C (131 °F)
         Core #3                    37 °C (98 °F)    35 °C (95 °F)   43 °C (109 °F)
         Package                    38 °C (100 °F)   36 °C (96 °F)   55 °C (131 °F)
      Powers
      Clocks
         Core #0                    3999 MHz         800 MHz         4399 MHz
         Core #1                    3999 MHz         800 MHz         4399 MHz
         Core #2                    3999 MHz         800 MHz         4399 MHz
         Core #3                    3999 MHz         800 MHz         4399 MHz
      Utilizations
   CT960BX200SSD1
   Intel(R) HD Graphics 4600
   NVIDIA GeForce GTX 1070
      Temperatures
         TMPIN0                     48 °C (118 °F)   48 °C (118 °F)  48 °C (118 °F)
      Fans
      Fans PWM
      Powers
      Clocks
      Utilizations
```

TEMPERATURE TANTRUMS?

Quickly diagnosing problems can be a lifesaver. If you're worried you're having temperature issues, or your processor is throttling under load, try HWMonitor. One of the most useful programs ever, it measures everything from temperature to clock speeds, to voltages, and utilization, making it easy to see whether there's a problem anywhere in your system. Head to www.cpuid.com/softwares/hwmonitor.html and try it for free.

MAKE – USE – CREATE

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Power up your Plex media server

68
The ultimate upgrade

ZAK STOREY
REVIEWS EDITOR

UPGRADING MY PERSONAL RIG

Ever since we made our mini water-cooled Dream Machine back in July, I've been fortunate enough to look after it. But, alas, I found a massive leak emanating from the GPU waterblock fittings, so I decided to strip the system, swap out the Fury X for a GTX 1070, and run an AIO instead.

The problem is, I'm getting a little frustrated with a couple of issues. Firstly, the noise. Although I've got four Noctua NF-F12 iPPC fans, they have a rated operating RPM of around 1,100–2,000, and while that's fantastic for pushing vast quantities of air at high pressure, it's less than amicable when it comes to noise. Couple that with the somewhat antiquated fan tech in the Corsair AX1200i PSU and the GTX 1070, and, well, you get where I'm coming from.

To counter this, I've opted to do a few things. I'm swapping to another chassis entirely, going from the Manta to the NZXT Source 340 Elite instead. I'm also swapping out the power supply for a Corsair HX1000i, which fortunately has 0dB fan tech. And I'm swapping the Noctua NF-F12s for three Corsair ML120 Pros with white LEDs, too. Not only will the ML120s add a hint of movement and color to my new build, but they also operate at as little as 400rpm at their lowest settings—perfect for a silent system.

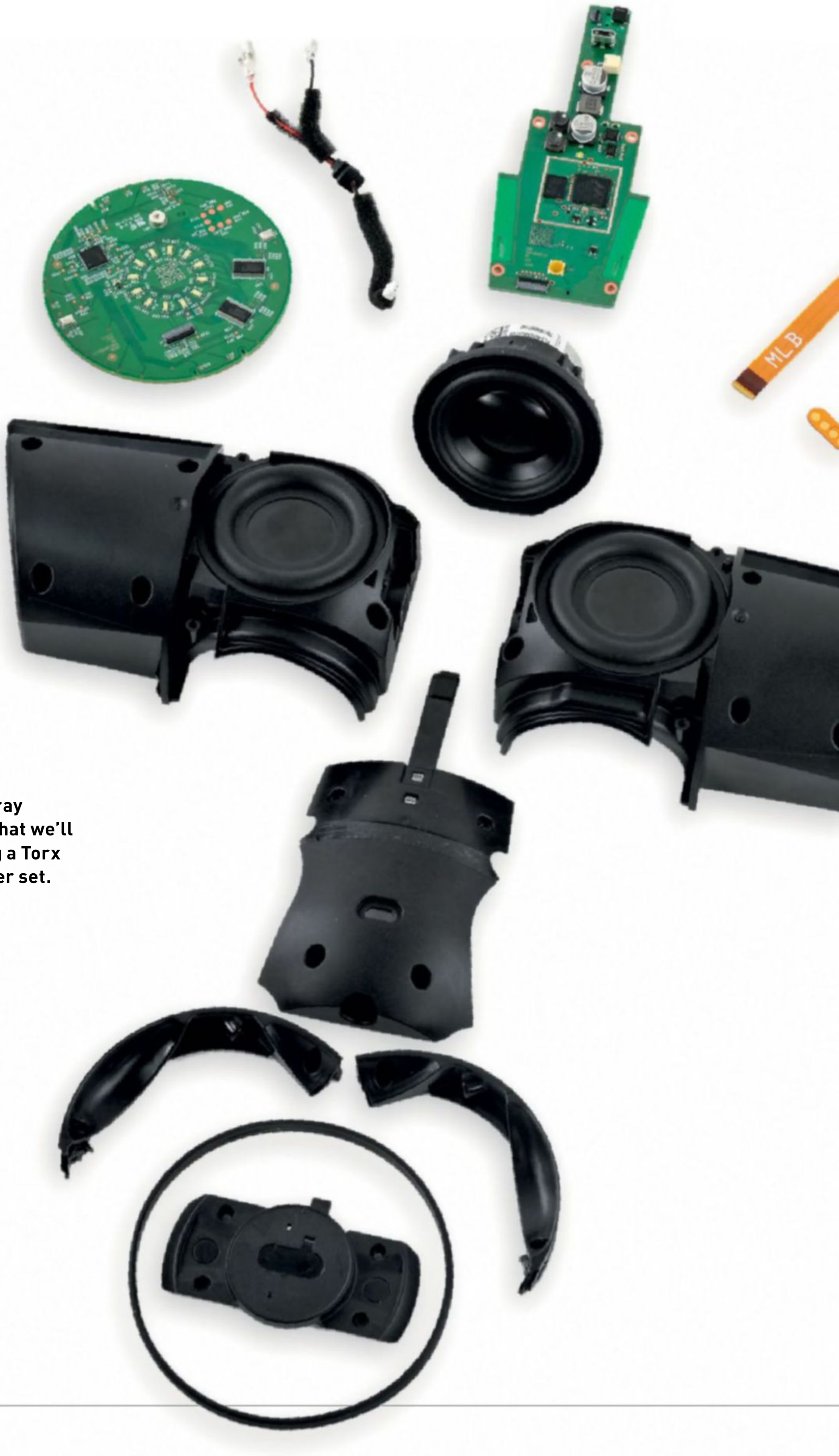
There are a few extra upgrades going on, too, but if you want to find out about those, you'd best take a look at "Build It" this issue, on page 68.

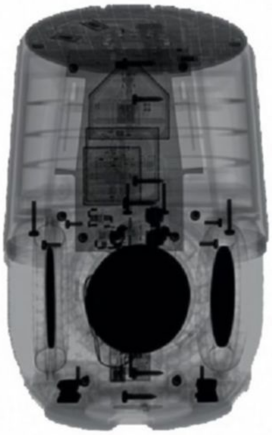
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT
presents:

AUTOPSY

THIS MONTH WE DISSECT...





A quick X-ray shows us that we'll be needing a Torx screwdriver set.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products.
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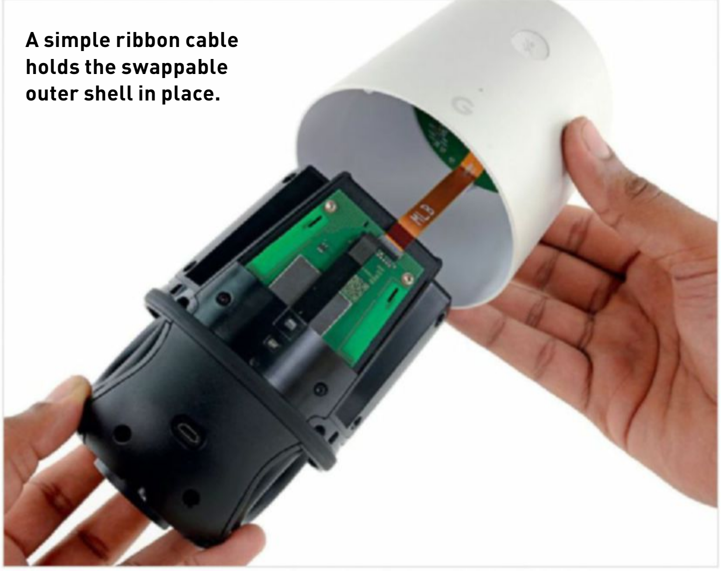
Google Home

No hidden anomalies here, no sir.



A simple ribbon cable holds the swappable outer shell in place.

BACKGROUND

Google wants to bring the robot assistants of the future to the world today. Equipped with Google Assistant, the Google Home is raring to work with smart home devices, support Google services, and answer questions. Does it have what it takes to fulfill your futuristic fantasies? Time to tear down the Home!

MAJOR TECH SPECS

- High-excursion speaker with two-inch driver and dual two-inch passive radiators
- Far-field microphones
- Customizable base
- 802.11ac (2.4GHz/5GHz) Wi-Fi
- Touch surface controls

KEY FINDINGS

- Removing the base gives us our first look at that high-excursion speaker and a hidden micro-USB programing/debug port. To pull out the four Torx screws hiding deep in the speaker recess, we grab our fixed-blade screwdrivers for a little extra reach. Once they're out, we pop the top. The lid separates with ease, and finally the capsule is open.
- After sending out a few test signals, we move on to disconnect a pesky interconnect cable. This runs from the motherboard up to a board tucked in the top of the lid, probably home to a fancy microphone and LED array.
- There's some seriously strong adhesive holding this board to the upper case. With a final yank (and a big dose of isopropyl alcohol to dissolve the glue), the LED board comes free to reveal the source of our struggle: a ton of adhesive tape.
- The stretchy O-ring seems to be the key to delving even deeper inside this smart speaker. In addition to its role as a gatekeeper, the O-ring probably also functions as a vibration dampener. This seems a more repair-friendly solution than the layer of stuck-down fabric on the Amazon Echo.
- The bit that holds the magnets for the bottom case also has a mystery cable locked inside it. Closer inspection reveals: yet more mystery! The cable sports four contact points. Perhaps more testing points? Alternate (made-up) theories: Recognizes the base color, so the Home can co-ordinate its outfits better; vestigial charging mechanism (maybe the Home's architects intended it to be portable); abandoned Easter egg dungeon level for teardown engineers.
- Repairability Score: 8 out of 10 (10 is easiest to repair). Minimal moving parts mean there are minimal points of failure. Only standard screws and connectors are used throughout the device. Many components are modular and can be replaced individually. The DC-in port is soldered to the motherboard, but is unlikely to experience much wear, considering the device stays plugged in. The touch board is strongly adhered to the upper case.

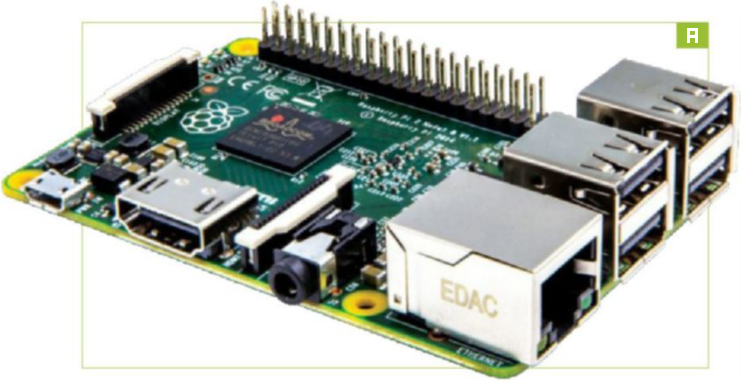
Create a Clever Wall Calendar

YOU'LL NEED THIS

RASPBERRY Pi
The brilliant mini-computer costs under $45. See www.raspberrypi.org.

ONE STAPLE IN FUTURISTIC FILMS is that everyone has a handy panel on the wall showing their appointments for the day. While we have calendars on our smartphones and tablets, now, thanks to the Raspberry Pi, it's possible to have an economic wall-mounted calendar in your home or office.

Given that we have just admitted that we could, for instance, use a calendar app on our phones instead, is this just a novelty, or are there any advantages to doing this? Well, mounting your calendar on a wall is certainly more aesthetically pleasing than many smartphones, but the main advantage is that it enables you to share a calendar with others, by putting it in a public place, such as your living room. Your family can see your own appointments, and you can make sure you schedule your commitments around theirs. In the workplace, you can use calendar views, such as Agenda in Google Calendars, to organize meetings and assign tasks to colleagues. –**NATE DRAKE**



1 CRAFTING YOUR CALENDAR

For this project, you need a Raspberry Pi with Internet access [**Image A**]. In the interests of saving on cabling and space, it's best to use the Raspberry Pi 3, which has integrated Wi-Fi.

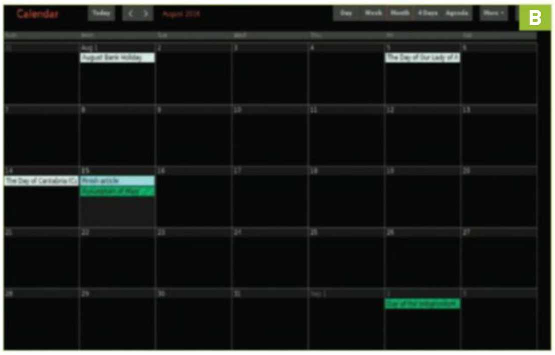
» You also need to choose a monitor. One excellent option is the Official Raspberry Pi Touchscreen Display (see "Choosing a Monitor," opposite) but any compatible monitor will do. This isn't a DIY tutorial, so please only attempt to mount the Raspberry Pi and display if you are comfortable with using a drill and installing brackets. If the display comes with a stand, there's no reason it can't be placed on a desk or table.

» This is also a good time to start measuring cable lengths, so you can be sure both the monitor and the Pi will have power wherever they're mounted.

» Once your equipment is in order, you need to consider the type of calendar you wish to use. If you and your family or colleagues already have a calendar you share, you can start following the tutorial right away.

» If that's not the case, you may wish to create a single calendar for this purpose. If you're using Google Calendars, you can follow the steps at https://support.google.com/calendar/answer/37095?hl=en to do this. For Mac users, visit https://support.apple.com/kb/PH2674?locale=en_US to create a new iCloud Calendar. Outlook users can also create a calendar by visiting http://calendar.live.com.

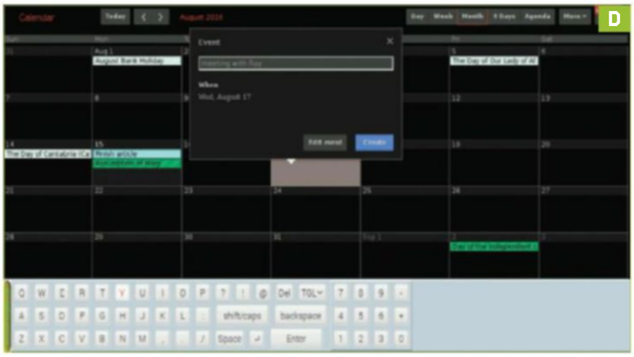
» It's not particularly important which calendar service you use, provided it can be displayed in Mozilla Firefox, which we're using for this project. Try to give the calendar a distinctive name, such as "Smith Family Calendar," so everyone using it knows it's distinct from their personal calendar.



2 IMPORTING CALENDARS

If you do have an existing calendar, you may wish to import your personal appointments, birthdays, and so on into the new one. It may not be necessary, because providers such as Google and iCloud allow multiple calendars. Events are color-coded to show which calendar they belong to [**Image B**].

» However, if one of the people using your new calendar previously used a different platform—for example, you have decided that you will all use a Google Calendar, but



one person has been using an iCloud one on their iPhone—you need to import it.

» To import events from an iCloud Calendar into Google, first export them into an ICS file by following the steps at https://support.apple.com/kb/PH11524?locale=en_US. Then import the file by following Step 2 at https://support.google.com/calendar/answer/37118?hl=en.

» To export a Microsoft Outlook Calendar to Google Calendar, follow the steps at http://bit.ly/2cl17lN.

3 CUSTOMIZATION

Once you have a single, shared calendar, take some time to set it to a format with which you're comfortable. Most providers have the option of a daily, weekly, or monthly view.

» Next, feel free to fine-tune the appearance. You can make changes to the iCloud Calendar—for example, to change the viewable time period—by following the instructions at https://support.apple.com/kb/PH2678?locale=en_US.

» Google Calendar's default look and feel is rather spartan. If you would like to experiment with different themes, there's a number available from https://userstyles.org/styles/browse?search_terms=google+calendar. However, you need the Stylish Firefox extension in order to install them, so visit https://addons.mozilla.org/en-US/firefox/addon/stylish/?src=ss, then click "Add to Firefox" to install this.

4 FULL-SCREEN AHEAD

Because you'll be using a much smaller screen than you're used to, space will be at a premium, so consider installing the Real Kiosk (r-kiosk) add-on for Mozilla Firefox. Real Kiosk does what it says on the tin: It's designed to turn your browser into the equivalent of an Internet kiosk. This means the menus, toolbars, and even the right-click function are disabled. The chief advantage of this is that Firefox always opens in full-screen mode, making your calendar much easier to see. This also makes sure your device can only be used as a calendar, because people trying to view other websites are bounced back.

» If you do need to close down Firefox for any reason, you can do this by connecting a keyboard, holding down the Alt key, then pressing F4.

5 EDITING YOUR CALENDARS

Reading this project so far, it would seem that viewing the calendar in the web browser is a passive experience. However, if you have a central calendar on your wall, wouldn't it be ideal to let people add and edit appointments as well?

» If you are using the official Raspberry Pi Touchscreen Display [**Image C**], tapping anywhere with your finger simulates moving the mouse and left-clicking in that place. You can use this to edit the time of events, and even create new ones.

» Problems may arise when you want to edit the text of events or create names for new ones. Naturally, you could connect a small wireless keyboard, and leave it near the wall-mounted calendar in case data needs to be entered.

» A much less clumsy solution, however, would be to have the keyboard built into the browser itself. The Mozilla Firefox extension VKeyBoard [**Image D**] is designed for kiosk browsers, and pops up when clicked to allow users to enter text.

» Simply visit https://addons.mozilla.org/en-US/firefox/addon/vkeyboard/?src=search inside the browser, and click "Add to Firefox" to install. If you have already installed the r-kiosk add-on, and can't change your web page, restart Firefox in safe mode, as outlined above.

6 SHARING THE DATES

If you want to use any device besides the Pi to add or change appointments in Google Calendar, you either need to sign into your Google or iCloud account on that device, or share your calendar with others.

» To share your Google Calendar, follow the steps at https://support.google.com/calendar/answer/37082?hl=en. You can send a link to only certain email addresses,

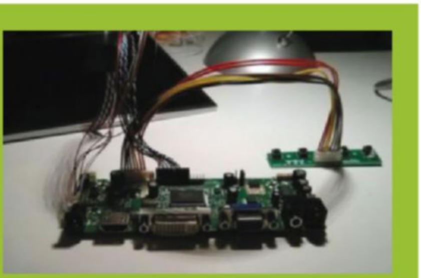
CHOOSING A MONITOR

There's no shortage of suitable small monitors to connect to your Raspberry Pi. If you feel comfortable with a small amount of wiring, the Official Raspberry Pi Seven-Inch Touchscreen Display is the ideal size to display a calendar, as well as having a handy slot at the back to place your Pi. The screen, along with assembly instructions, is available from the Adafruit website for $80 (www.adafruit.com).

If you don't like messy wires all over the place, Amazon sells a short micro-USB power cable for about $3, to allow the Raspberry Pi to draw power from the monitor's USB port.

The Touchscreen Display has the added advantage of enabling you to scroll through appointments with a click of a finger. If this isn't important, or the display is out of your budget, Amazon and eBay also sell Pi-compatible displays. As the Pi has an HDMI port, any HDMI-compatible monitor will do, but some come with a driver board to allow you to connect it to the Pi's own DSI port.

If you are very comfortable with electronics, and want to save money, find a broken-down laptop with a working LCD. If you can remove the screen safely and buy a compatible controller board online, it can be made to work with the Raspberry Pi. Visit www.instructables.com/id/Old-laptop-screen-into-Monitor/?ALLSTEPS for some tips.



E

or make the calendar viewable to anyone with the link. You can do the same for iCloud Calendars by following the steps at https://support.apple.com/kb/ph2690?locale=en_US.

» If you use Outlook 2010, it's also possible to publish a calendar to Outlook.com by visiting https://support.office.com/en-ie/article/Share-an-Outlook-calendar-with-other-people-cafb9303-1b1e-40d3-839d-b6abac03a5e8#__toc300732657, and following the section entitled "Share a Calendar by Publishing it Online."

» Once your calendar has been shared online, people who wish to edit it need to access it from their own devices. For anyone with a computer, this is a simple matter of visiting the link, as you would on the Pi, by using their browser.

» It's also possible to view and edit the calendar on smartphones. If the shared calendar is with Google, Android users can access it from their own calendar app, even if they have a different Google account, by following the instructions at https://support.google.com/calendar/answer/37100?co=GENIE.Platform%3DDesktop&hl=en. There is an official Outlook app for Android, which allows for easy viewing and editing of Outlook calendars. Sadly, iCloud Calendars aren't so easy, but there's a number of third-party apps, such as SmoothSync, in the Google Play store, which enable you to synchronize between calendars. If you are an iPhone user, you're in luck. There's an official Google Calendar app in the iTunes Store, with which you can sign in and view your calendars. There is also an official Microsoft Outlook Email and Calendar app, which can be used to view and edit Outlook Calendars.

7 CALENDAR CONUNDRUMS

If you create or change an appointment, and it doesn't appear right away on everyone's device, wait for 5–10 minutes before attempting troubleshooting, to let it percolate through. If the changes are visible on the wall calendar—that is, on the website—the issue is most likely to do with the device, not the Raspberry Pi.

» The software and add-ons used to view the calendar are very easy to install, so the most problematic part of this project is likely to be when it comes to adding the monitor, and fixing it to your wall [**Image E**].

» You can make life much easier for yourself by buying a monitor specifically designed for the Raspberry Pi, so you have somewhere to put the computer itself.

» If the place you want to install the wall calendar is hard to reach, you may be able to buy a longer micro-USB cable, but bear in mind that the voltage drops as cable length grows. Consider using shorter cables and/or a powered USB hub.

» If the Raspberry Pi crashes for any reason, Firefox tries to restore all open web pages once it reboots, which may mean you have to plug in a mouse or keyboard to close down any extra tabs.

» You can reduce the chance of this happening by starting Firefox in safe mode, and then entering "about:config" in the address bar. Press Return to be taken to the settings screen for Firefox.

» Once you're there, simply scroll down to the setting marked "Browser.sessionstore.resume_from_crash," and double-click to change from "True" to "False."

» If you are using Google Calendars, anyone who scrolls to the top of the screen can switch from your calendar to your other Google Apps, such as Gmail. They can also use the search bar to view documents stored in your Google Drive.

» If this concerns you, consider setting up a dedicated Google account, just for the calendar. You can still access and edit the calendar from your own account. ⏻

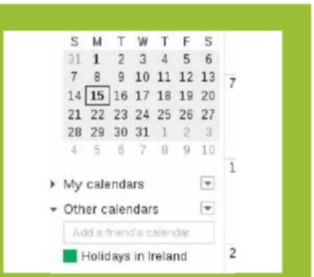
CALENDAR TWEAKS & TIPS

When the calendar is on your wall, the cursor can look untidy, especially when using a touchscreen. A handy app called Unclutter can hide the cursor except when it's being moved or you're touching the screen. Open Terminal on your Pi (or connect via SSH), and run the command `sudo apt-get install unclutter`.

In case the Pi crashes, and you're forced to reboot, it's best to have Firefox programmed to open automatically, saving you the trouble of reconnecting a keyboard and mouse. Open Terminal on your Pi (or connect via SSH), and run the command `sudo nano /etc/xdg/lxsession/LXDE-pi/autostart`. Scroll to the bottom of the window and add the line `@firefox-esr`. Press Ctrl-X, then Y, then Return to save your changes.

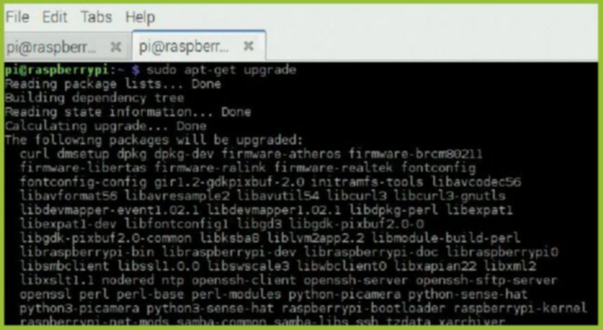
Finally, to make sure the display doesn't sleep after a few minutes, open Terminal or connect via SSH once again, and run the command `sudo nano /etc/lightdm/lightdm.conf`. Scroll down to where it says `#xserver-command=X` and remove the hash at the start of the line. Next, put a space after the letter `X` and type `-s 0 –dpms`. Press Ctrl-X, then Y, then Return to save your changes, then reboot your Raspberry Pi.

If you are using Google Calendars, click the arrow beside "Other Calendars," then "Browse Interesting Calendars," to see a list of calendars to which you can subscribe—for example, Holidays in Ireland. Click "Subscribe" to have them appear on your own calendar.



S	M	T	W	T	F	S
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3
4	5	6	7	8	9	10

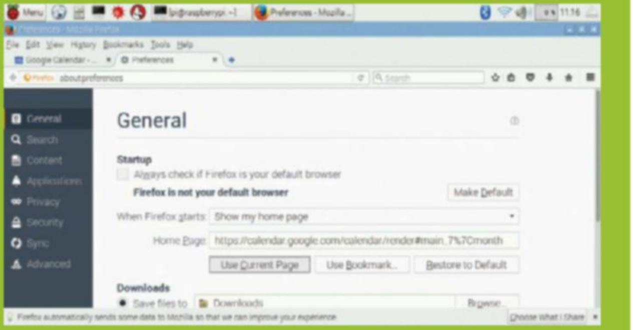
SET UP YOUR WALL CALENDAR


File
Edit
Tabs
Help
pi@raspberr...
pi@raspberr...

```
pi@raspberrypi:~ $ sudo apt-get upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages will be upgraded:
  curl dmsetup dpkg dpkg-dev firmware-atheros firmware-brcm80211
  firmware-libertas firmware-ralink firmware-realtek fontconfig
  fontconfig-config gir1.2-gdkpixbuf-2.0 initramfs-tools libavcodec56
  libavformat56 libavresample2 libavutil54 libcurl3 libcurl3-gnutls
  libdevmapper-event1.02.1 libdevmapper1.02.1 libdpkg-perl libexpat1
  libexpat1-dev libfontconfig1 libgd3 libgdk-pixbuf2.0-0
  libgdk-pixbuf2.0-common libksba8 liblvm2app2.2 libmodule-build-perl
  libraspberrypi-bin libraspberrypi-dev libraspberrypi-doc libraspberrypi0
  libsmbclient libssl1.0.0 libswscale3 libwbclient0 libxapian22 libxml2
  libxslt1.1 nodered ntp openssh-client openssh-server openssh-sftp-server
  openssl perl perl-base perl-modules python-picamera python-sense-hat
  python3-picamera python3-sense-hat raspberrypi-bootloader raspberrypi-kernel
  raspberrypi-net-mods samba-common samba-libs ssh tzdata xarchiver
```

1. UPDATE RASPBIAN AND INSTALL FIREFOX

Before you can physically transform your Raspberry Pi into a wall calendar, you need to connect the device to the Internet, and open the Terminal app. Run `sudo apt-get update` and then `sudo apt-get upgrade` to bring your RPi up to date. Next, enter `sudo apt-get install iceweasel` to install Firefox Extended Support Release on to your mini computer.


Menu
pi@raspberrypi: ~
Preferences - Mozilla...
11:16
File
Edit
View
History
Bookmarks
Tools
Help
Google Calendar - ...
Preferences
about:preferences
Search
General
Search
Content
Applications
Privacy
Security
Sync
Advanced
Make Default
Use Current Page
Use Bookmark...
Restore to Default
Browse...
Choose What I Share

General

Startup

☐ Always check if Firefox is your default browser

Firefox is not your default browser

When Firefox starts: Show my home page

Home Page: https://calendar.google.com/calendar/render#main_7%7Cmonth

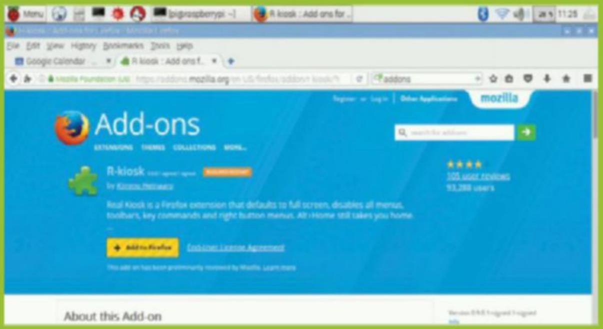
Downloads

● Save files to Downloads

Firefox automatically sends some data to Mozilla so that we can improve your experience.

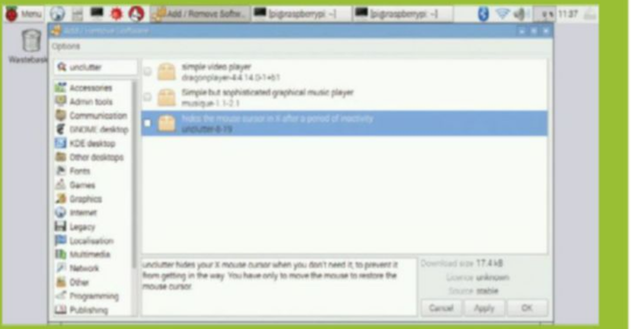
2. SET FIREFOX PREFERENCES

Go to "Menu → Internet → Firefox ESR" to open Firefox. Visit your calendar address—http://calendar.google.com, for example—and sign in if necessary. If Firefox prompts you to remember your preferences, say "Yes." Once you can see your calendar, go to "Edit → Preferences," and click the "Set to Current Page" button to make sure Firefox always displays the calendar.


Menu
pi@raspberrypi: ~
R-kiosk :: Add-ons for...
11:28
Google Calendar
R-kiosk :: Add-ons f...
addons
mozilla
Add-ons
R-kiosk
Add to Firefox
About this Add-on

3. SET FIREFOX FOR FULL-SCREEN

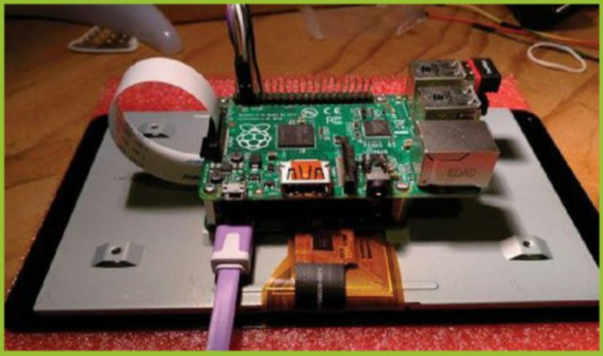
This step is optional but recommended. Visit https://addons.mozilla.org/en-US/firefox/addon/r-kiosk/ to install the Real Kiosk add-on—this disables menus and toolbars. Firefox needs to restart for it to work. Remember, you can still close the window by connecting a keyboard to the Raspberry Pi, and pressing Alt-F4.


Menu
Add / Remove Softw...
pi@raspberrypi: ~
pi@raspberrypi: ~
11:37
Wastebasket
Options
unclutter
Accessories
Admin tools
Communication
GNOME desktop
KDE desktop
Other desktops
Fonts
Games
Graphics
Internet
Legacy
Localisation
Multimedia
Network
Other
Programming
Publishing
simple video player
Simple but sophisticated graphical music player
hides the mouse cursor in X after a period of inactivity
Cancel
Apply
OK

unclutter hides your X mouse cursor when you don't need it, to prevent it from getting in the way. You have only to move the mouse to restore the mouse cursor.

4. PERFORM TWEAKS

Make sure the calendar is in the view you want—for example, Monthly. Next, follow the steps in the "Calendar Tweaks and Tips" box (opposite) to hide the mouse when not in use, disable the RPi's sleep function, and make Firefox start every time you switch on the machine, if you wish. Restart the RPi to ensure your changes have taken effect.



5. CONNECT IT UP

The specific steps to connect your monitor vary from device to device. If you are using the official Raspberry Pi Touchscreen Display, assembly instructions are available from http://thepihut.com/blogs/raspberry-pi-tutorials/45295044-raspberry-pi-7-touch-screen-assembly-guide.

6. FINISHING TOUCHES

Once you've connected your Raspberry Pi up to a screen, you'll want to position it somewhere that everyone can access. If it's in your home, you'll probably also want to make it look as good as possible. You can let your imagination run wild here—take a look online to see what other people have achieved.

Edit Raw Files with Affinity Photo

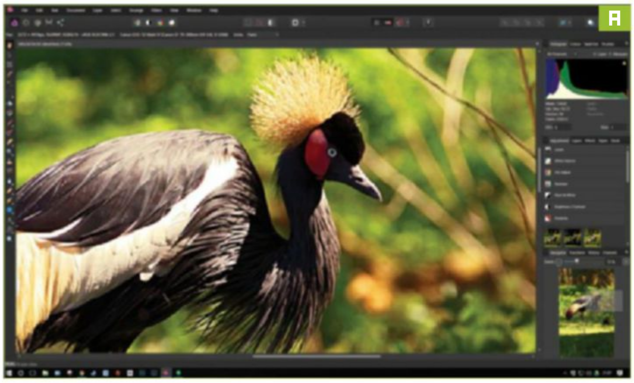
YOU'LL NEED THIS

AFFINITY PHOTO PUBLIC BETA
Download the software from http://affinity.serif.com.

A RAW IMAGE FILE
Your smartphone might oblige.

IF YOU HAVE A DIGITAL SLR CAMERA or advanced compact, you might have wondered what the "raw" image quality setting is about. Or you may know all about it, and are squinting your eyes at this patronizing opening paragraph. A raw capture is a simple dump of the information gathered by your camera sensor, with no processing applied, other than that needed to turn it into a PC-readable file. No noise reduction, no additional sharpening, and no compression. This can be a big advantage.

Shooting in raw shifts the burden of processing your images from your camera to your PC, where you can manually affect the process with software such as Adobe Lightroom. For this tutorial, however, we're going to use the free beta version of Serif's Affinity Photo, which is currently available as the software prepares for a Windows release. It's been available in the land of Apple for a while, so should be relatively bug-free as it transfers across. Famous last words. **–IAN EVENDEN**



1 GRAB THE SOFTWARE AND AN IMAGE

The Affinity Photo Windows beta can be downloaded from http://affinity.serif.com—the testing version is free at the moment, but you have to supply an email address to get it. Once you've got the application installed on your computer, you need to find a raw image file that you want to process. These have file extensions such as .CR2, .NEF, and .DNG, and if you've got one of the better smartphones, you may even be able to coax one out of the onboard camera. A list of supported cameras can be found at http://bit.ly/Affinity-raw, and includes everything from 4K Black Magic Production cameras to Canon DSLRs and LG Android smartphones.

2 OPEN THE IMAGE

If you were to open your raw file in an Adobe application, such as Photoshop, you would be taken to Adobe Capture Raw. Naturally, Affinity Photo doesn't use this, but has its own raw processing system, which opens as a full-screen app, rather than the small window Adobe prefers.

3 THE DEVELOP PERSONA

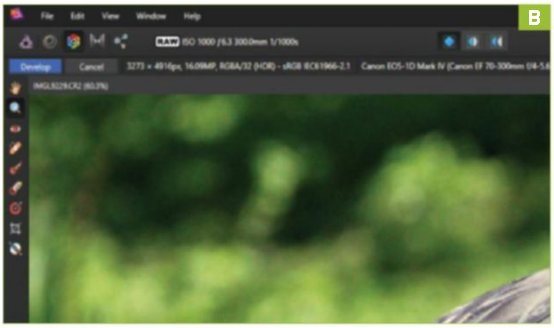
Once you've got your file open, the interface looks a little different from the usual Affinity Photo one [**Image A**]. This is Develop, one of Affinity Photo's "personas"—the term Serif uses to differentiate between the application's various modules. To the left, you'll find a selection of tools for manipulating the view of your photo, removing red-eye and blemishes, and cropping the image; and to the right are the tools and sliders you use to alter your photo before opening it in Affinity proper. A raw file is never directly edited—instead, you build up a list of edits that are only applied once you click the blue "Develop" button at the top-left, and enter the Photo persona [**Image B**]. Affinity then generates a new file, which you save as a JPEG or TIFF, leaving your original raw file wherever you saved it, rather like a digital negative.

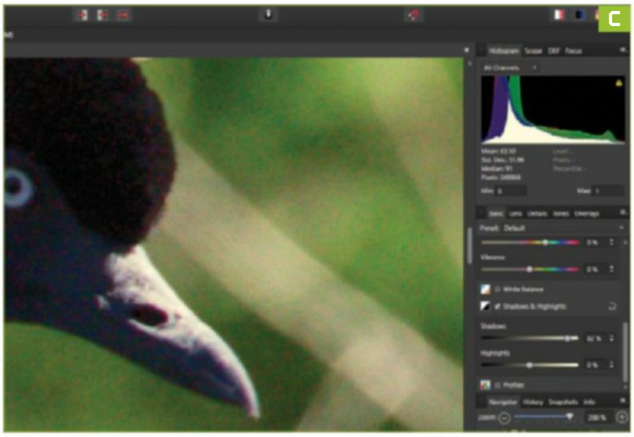
4 EXPOSURE

The most commonly applied adjustments are grouped in the "Basic" tab. These are things such as exposure, which you can push up or down to brighten or darken the overall picture. A raw file captures the full bit-depth of the sensor, which is often 14-bit, rather than discarding information the way an 8-bit JPEG would. This means there is more potential detail to be recovered from the highlights and shadows of an image, so you can push the exposure the way film was once pushed in a darkroom, as though it were a higher sensitivity than marked. Be aware, though, that the more you increase exposure, the more noise you're likely to reveal, particularly in shadows, thanks to the way camera sensors record less information in darker areas.

5 NOISE REDUCTION

If you just want to brighten the dark areas of your image (or darken the highlights), look further down on the right, and you'll find "Shadows and Highlights." Check this box, and two sliders appear that allow you to make finer adjustments to the brightness of your image. If the noise levels—either pixels that are the wrong color for their area of the image, or a grain-like pattern where





they're the wrong brightness—get out of hand, you can move over to the "Details" tab, where you'll find "Noise Reduction" [**Image C**]. This is split into two parts—for color noise and luminance noise—and comes with a rather awesome button marked "Extreme," for those times when you really want to go to town. It's worth noting, though, that noise reduction isn't perfect, and can remove detail from your image.

6 SHARPEN YOUR IMAGE

The "Detail Refinement" section above "Noise Reduction" is Affinity's term for sharpening. All JPEG images shot on a digital camera are sharpened as part of the processing applied by default, so you may find your raw files a little soft by comparison. Bringing out the extra detail hidden in the feathers of our crane is a matter of bringing up the "Amount" slider to around halfway, then gradually upping the "Radius" slider until we're happy with the result. If your image is noisy, sharpening can enhance this instead of the underlying detail, so it pays to keep an eye on what's happening across your image.

HISTOGRAM

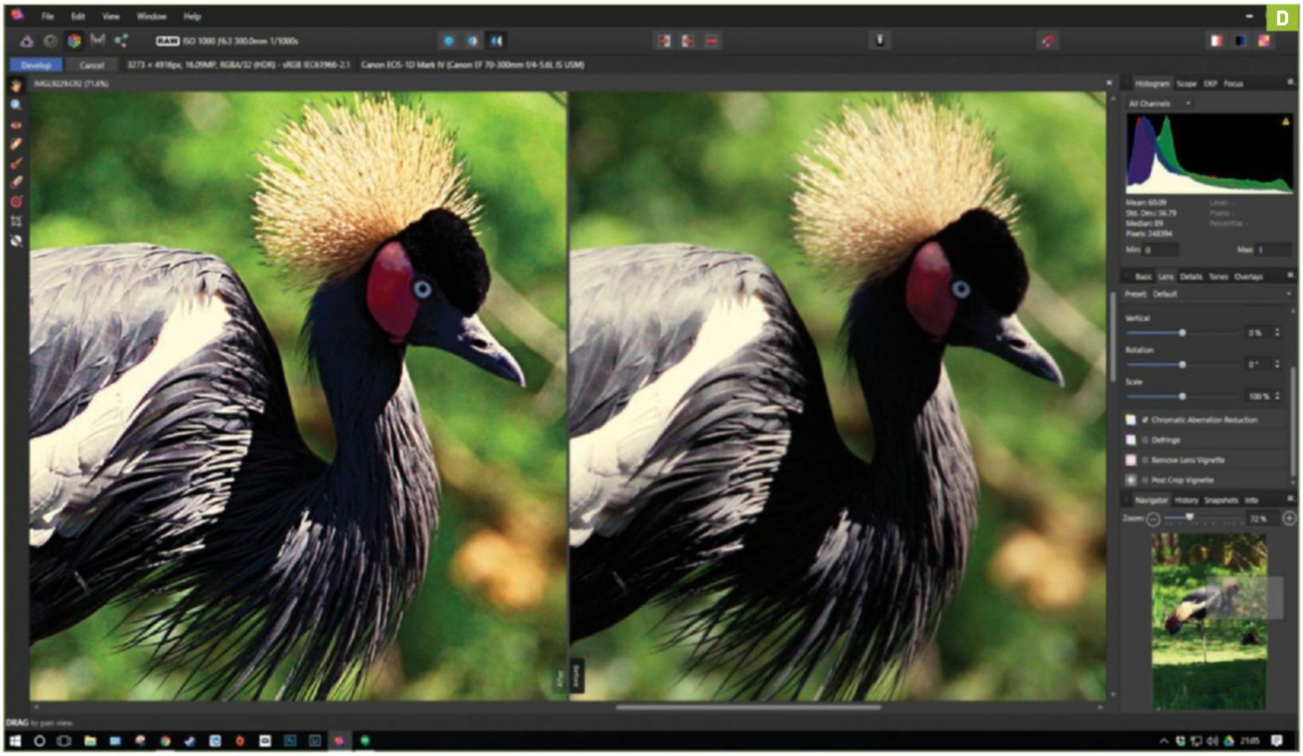
At the top of many image-editing programs is a histogram. This is a graph showing the brightness of your image on the X axis, with the number of pixels at that brightness on the Y. You can use this to see if your image has highlights that are pure white—known as "clipped"—and from which no detail can be extracted. Affinity has a "Show Clipped Highlights" button, top-right, which shows these up as red areas in your image. The opposite, shadows that are pure black, can be revealed in blue with the "Show Clipped Shadows" button. As you alter the brightness of your image, you can watch the histogram to get an idea of how much latitude you have before areas start to clip.

7 REMOVE DISTORTION

The "Lens" tab is home to tools that can remove distortion, especially useful if you've been tilting your camera up at a tall building, or had a wide-angle lens too close to the face of someone with a prominent nose. More handy, and able to be applied with a single click, is the "Chromatic Aberration Reduction" box beneath—this removes the fringing you sometimes get in high-contrast images, which comes from a lens focusing different wavelengths of light on to different parts of the sensor.

8 KEEP EXPERIMENTING

Because none of these adjustments are permanent until you hit the "Develop" button, you can toy with the sliders to your heart's content. Any change you make can be undone by pushing the slider in the opposite direction, and Affinity makes it easy to see what you're doing with its Mirror view [**Image D**], which puts altered and unaltered versions of your image side by side. ⏻


D
File
Edit
View
Window
Help
Develop
Cancel
Canon EOS-1D Mark IV (Canon EF 70-300mm f/4-5.6L IS USM)
Histogram
Scope
EXIF
Focus
All Channels
Basic
Lens
Details
Tones
Overlays
Preset: Default
Vertical
Rotation
Scale
Chromatic Aberration Reduction
Defringe
Remove Lens Vignette
Post Crop Vignette
Navigator
History
Snapshots
Info
Zoom
72 %

Power Up Your Plex Media Server

YOU'LL NEED THIS

HARDWARE

Suitable low-end PC, NAS, or Raspberry Pi 2 or 3.

PLEX MEDIA SERVER

See www.plex.tv.

IF YOU'RE LOOKING FOR A MEDIA SERVER that doesn't just enable you to organize and play your media, but shows it off in the best possible way, you need Plex. It works across just about any device you own, and enables you to watch across multiple platforms, both at home and over the Internet, picking up where you left off watching on another device.

The biggest issue with Plex is choosing the server to run it on. A PC is an obvious choice, but it needs to be left on 24/7 for unlimited access. You're better off installing it on a dedicated low-power device, such as a high-end NAS, like QNAP's TS-251+, which boasts a quad-core Celeron CPU and hardware transcoding engine. But that's not necessarily affordable, so a cheaper NAS with app support (like the WD My Cloud [**Image A**]) or a Raspberry Pi 2 or 3 is capable of serving media.

The major trade-off is performance—you free up resources from your main PC, but your server is slower and visibly less responsive. It still does the job, though, and armed with the following tips, you'll squeeze that bit more performance from it to deliver a great media experience. **–NICK PEERS**

A

1 USE THE RIGHT FORMAT

The most effective way to improve performance is by reducing—or even eliminating—transcoding. Transcoding converts your media stream from its native format to one that's compatible with your media-playing device, so the more exotic and varied your media formats are, the more likely it is that Plex needs to transcode them.

›› Wherever possible, save your media in .mp4 file containers using the H.264 video and AAC or MP3 audio codecs—this is the closest to a universal format you can get, and most devices should be able to play it directly. Handbrake (www.handbrake.fr) can do this for you.

›› The critical elements here are the codecs—if you use a different file container (such as .mkv or .avi) with H.264 and AAC/MP3, Plex uses a process called Direct Stream to "remux" the file in a compatible container (typically .mp4) before streaming it. Although this requires extra processing power, remuxing is far less demanding than a full transcode.

2 ADD SUBTITLES

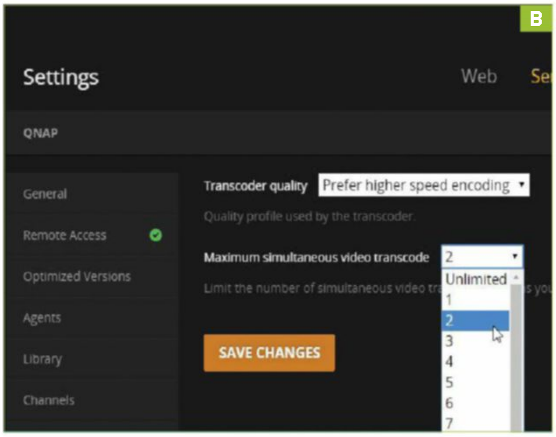
If you need subtitles, it's important to choose the right format if you use external files—otherwise Plex has to transcode the stream to accommodate them. Go to "Media Preparation → Subtitles" at https://support.plex.tv/hc/en-us for instructions. Here you'll discover which formats to choose to avoid transcoding (.srt and .vtt are two), along with a means of fetching subtitles on demand from the Internet using OpenSubtitles.org. Then browse to "Settings → Languages," check the "Automatically select" box, and set "Subtitle mode" to "Shown with foreign audio," and "Prefer subtitles in" to "English."

›› Subtitles are notorious for being out of sync—if your media player doesn't provide offset controls (typically in milliseconds), visit www.subsedit.com/simple to paste in your subtitles from a text editor, select an offset, and generate a new .srt file that syncs perfectly. Use VLC Media Player's "Tools → Track Synchronization" with the original .srt file to calculate the offset you need.

3 SPEED UP NETWORK CONNECTIONS

If you connect your server wirelessly to your network, you can improve its performance by taking it off your congested Wi-Fi network, and connecting it via Ethernet cable—either directly to your router, or indirectly via a switch or HomePlug network (500Mb/s is adequate, but 1,300Mb/s is best if your server frequently serves multiple streams).

›› Some NAS drives—including our beloved QNAP—offer dual Ethernet ports with support for Link Aggregation Control Protocol (802.3ad). Pair this with a suitable network

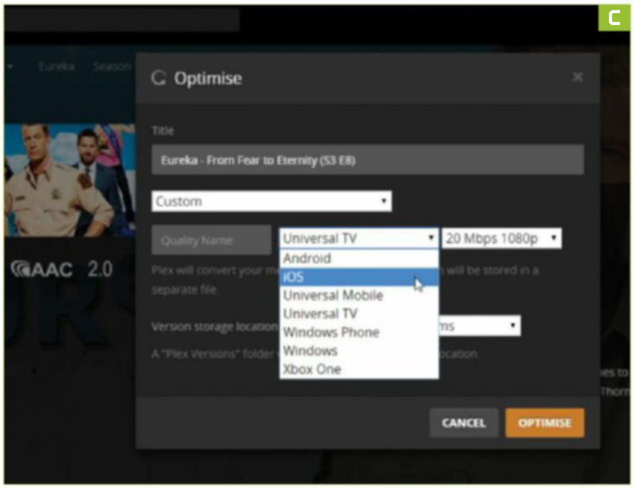

B

Transcoder quality: Prefer higher speed encoding

Quality profile used by the transcoder.

Maximum simultaneous video transcode: 2

Limit the number of simultaneous video tr



Title: Eureka - From Fear to Eternity (S3 E8)

Custom

Universal TV

20 Mbps 1080p

switch (such as TP-Link's affordable TL-SG2008 model), and you'll boost network throughput when serving multiple connections.

4 TRANSCODER SETTINGS

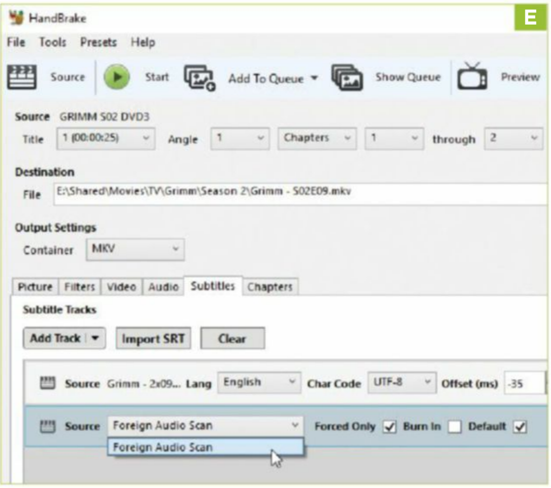
There's a noticeable lag when playing back media over the Internet—like it or not, this involves some transcoding, even with directly supported formats. To boost responsiveness at the expense of quality, log on to your server through your web browser: "192.168.x.y:32400/web," where "192.168.x.y" is the IP address of the device running your server. Choose "Settings → Transcoder," and set "Transcoder quality" to "Prefer higher speed encoding."

›› Plex is also set to transcode an unlimited number of streams—restrict this to just one or two via the "Maximum simultaneous video transcode" drop-down [Image B]. Note: This doesn't restrict Direct Play connections.

5 OPTIMIZE FOR TRANSPORT

Does Plex struggle to deliver a good stream to certain devices? You can use its Media Optimizer tool to make use of idle server time, by converting selected media files to a format that will stream using Direct Play, without buffering or dropping frames. The process produces a smaller, lower-quality copy of the file in question, which sits alongside the original, and improves streaming performance.

›› Don't optimize your entire library; instead, optimize on demand—maybe you're going away for a few days, and want access to three or four TV episodes or movies. To do this, log into the server in your web browser, then browse to the movie or episode in question. Click the "..." button in the left-hand pane, and choose "Optimize." Pick a preset: Mobile, TV, Original, or Custom (this latter option lets you choose from more presets, or set your own frame rate and resolution). Leave the default storage location alone, and click "Optimize" [Image C].



Source GRIMM S02 DVD3

Title 1 (00:00:25) Angle 1 Chapters 1 through 2

Destination

File E:\Shared\Movies\TV\Grimm\Season 2\Grimm - S02E09.mkv

Output Settings

Container MKV

Subtitle Tracks

Source Grimm - 2x09... Lang English Char Code UTF-8 Offset (ms) -35

Source Foreign Audio Scan Forced Only ☑ Burn In ☐ Default ☑

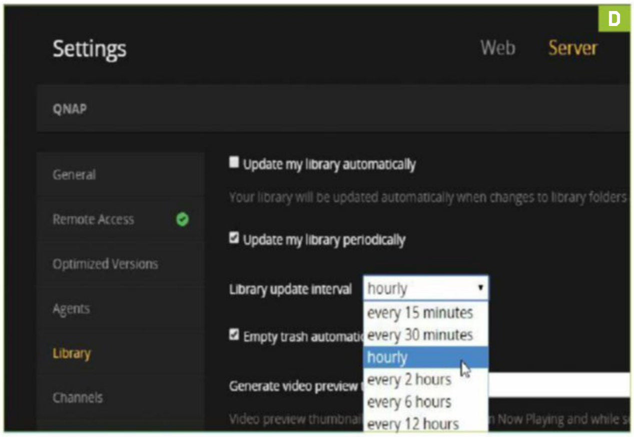
6 TWEAK OPTIMIZATION SETTINGS

Media is optimized one file at a time, but you can build a queue. Check their progress via the "Conversion" tab. To manage optimized versions—allowing you to delete some or all of these converted files to reclaim drive space at a later date—go to "Settings → Optimized Versions."

›› Return to "Settings → Transcoder," and click "Show Advanced." At the bottom of the screen, you'll see the "Background transcoding x264 preset" setting—it's set to "Very fast" by default, but consider "Super fast," or even "Ultra fast," if the optimization process is taking too long, and you're not bothered by video quality.

7 RESTRICT LIBRARY UPDATES

Go to "Settings → Library" to manage how Plex updates your media libraries. By default, it monitors for new and changed content in your media folders, then updates accordingly. This isn't practical on lower-end media servers, such as the Raspberry Pi, so restrict the scan to no more than once an hour using the "Update my library periodically" option instead. Also consider setting "Generate video preview thumbnails" and "Generate chapter thumbnails" to "Never" to reclaim more system resources [Image D].



☐ Update my library automatically

Your library will be updated automatically when changes to library folders

☑ Update my library periodically

Library update interval hourly

☑ Empty trash automati

Generate video preview

Video preview thumbnai

n Now Playing and while s

EMBED SUBTITLES

An alternative way to access subtitles is to embed them into your media using Handbrake. A full guide can be found under "Advanced Features" at https://handbrake.fr/docs/en/—but it's basically this: Load up your media, switch to the "Subtitles" tab, and either import your .srt file (you can set an offset if required), or click "Add Track" if ripping from DVD. Look for a "Foreign Audio Scan" option [Image E], which attempts to detect the foreign-language dialog track for you, then check both "Forced Only" and "Default" (or "Burn In" if you want the subtitles to be physically overlaid on the video track, which means they're visible even if subtitles are switched off). You'll never be bamboozled by Jabba the Hutt again.

Connect and Control with TeamViewer

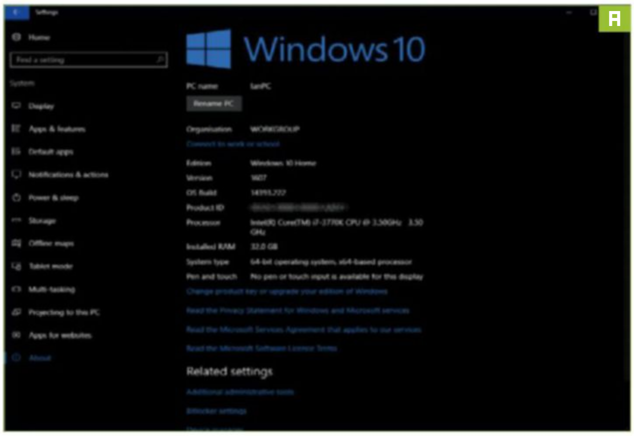
YOU'LL NEED THIS

TEAMVIEWER
Grab the app from
www.teamviewer.com.

TEAMVIEWER IS AN APPLICATION that enables you to view—and remotely control—another computer. Not just any old computer, however; the machine you're connecting to must have the client software installed, and approve your connection—this isn't an app for hackers. The link between the two computers is also encrypted, so no one can spy on what you're doing.

There are mobile apps, too, so you can complete a task on your home PC—left running and logged in—from a hotel room half the world away. All you need is your smartphone and some Wi-Fi.

TeamViewer is useful for training—you can allow your students to view your PC as you carry out the task you're teaching them. Or you can broadcast a presentation to a "meeting" filled with people scattered across the globe. Let's take a look! –IAN EVENDEN



PC name IanPC
Organisation WORKGROUP
Edition Windows 10 Home
Version 1607
OS Build 14393.222
Product ID [redacted]
Processor Intel(R) Core(TM) i7-3770K CPU @ 3.50GHz 3.50 GHz
Installed RAM 32.0 GB
System type 64-bit operating system, x64-based processor
Pen and touch No pen or touch input is available for this display

1 REMOTE DESKTOP

Before you dive into TeamViewer, Microsoft might be able to help with the Remote Desktop remote-control tool that's built into Windows [Image A]. It's been around since Windows NT 4 in 1998, and crossed over into our homes with Windows XP. In Windows 10, go to "Settings → System → About," and make a note of your PC's name, because you'll need this to allow other users to connect.

2 NEVER SLEEP

Set your PC so it doesn't go into Sleep mode in "Settings → System → Power & Sleep." Then make sure your PC can accept Remote Desktop connections in "Control Panel → System Properties → Remote." If you're on the same network, the Remote Desktop app on the PC or smartphone trying to connect should scan for you. You may need to find and supply your IP address.

3 ENTER TEAMVIEWER

Download the application from www.teamviewer.com. If you only want to use the program once, it's capable of running from the .exe file, rather than being fully installed on your PC. Select this box in the installation options if that's what you want. The application is free for personal use, so check the "Personal/non commercial" box for the free version.

4 ADVANCED OPTIONS

There are some more options available during setup. For instance, you can choose the directory the application is installed into [Image B]. The other options are for an Outlook plugin to co-ordinate meetings, plus advanced features, such as a VPN (virtual private network), and a printing server. These are the sort of things that need to be configured, and aren't required for basic use of the app.

5 BASIC CONNECTION

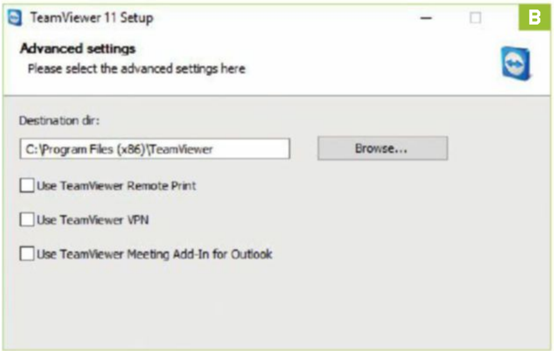
A good way to test whether it's working is to use your smartphone. There are free TeamViewer apps for iOS, Android, Windows Mobile, and Blackberry, so install one and link to your Wi-Fi. Run TeamViewer on your PC and smartphone, and type the user ID and password from your PC into the smartphone app [Image C]. You should get a good connection on the same Wi-Fi network.

6 MOBILE APPS

The mobile app strips out the wallpaper from your PC desktop, but you should see all the icons of your Windows desktop in front of a plain backdrop. Pinch to zoom in and out, scroll the mouse pointer around, and click to launch apps and open windows. The apps are useful for checking in on a relative's computer, or for administering a home server.

7 SHARE YOUR SCREEN

Now let's try connecting with another computer. There are apps for Mac and Linux, as well as Windows, so if you have a mixture of computers at home, they can all use the application—they don't all need to be using the same operating system. Once connected, you can operate the remote computer just as though you were sitting at its keyboard.



TeamViewer 11 Setup

Advanced settings

Please select the advanced settings here

Destination dir:

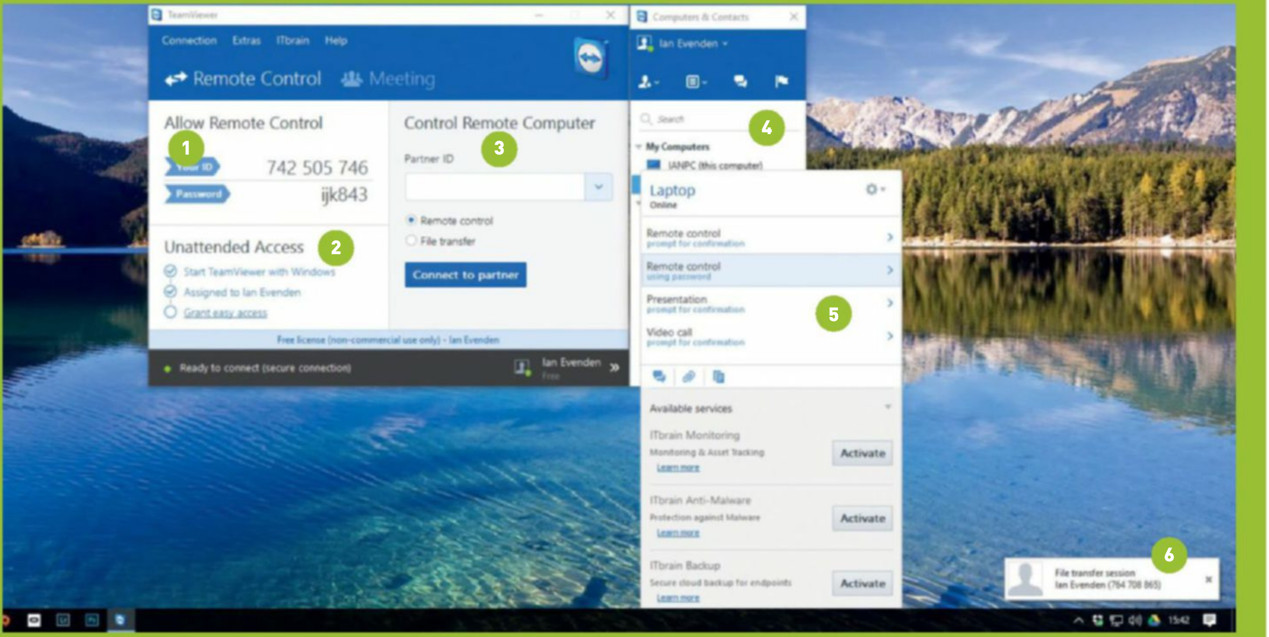
C:\Program Files (x86)\TeamViewer

☐ Use TeamViewer Remote Print

☐ Use TeamViewer VPN

☐ Use TeamViewer Meeting Add-In for Outlook

TEAMVIEWER ON VIEW


TeamViewer
Connection Extras ITbrain Help
Remote Control
Meeting
Allow Remote Control
1
Your ID 742 505 746
Password ijk843
Unattended Access
2
Start TeamViewer with Windows
Assigned to Ian Evenden
Grant easy access
Control Remote Computer
3
Partner ID
Remote control
File transfer
Connect to partner
Free license (non-commercial use only) - Ian Evenden
Ready to connect (secure connection)
Ian Evenden Free
Computers & Contacts
Ian Evenden
Search
4
My Computers
IANPC (this computer)
Laptop
Online
Remote control prompt for confirmation
Remote control using password
Presentation prompt for confirmation
5
Video call prompt for confirmation
Available services
ITbrain Monitoring
Monitoring & Asset Tracking
Learn more
Activate
ITbrain Anti-Malware
Protection against Malware
Learn more
Activate
ITbrain Backup
Secure cloud backup for endpoints
Learn more
Activate
6
File transfer session
Ian Evenden (764 708 865)

1. REMOTE CONTROL
This is the username and password needed to connect to your PC. You must pass the details to the person connecting.

2. UNATTENDED ACCESS
If you're setting up a server or other machine that's always on, you can configure this so it doesn't need a user.

3. CONTROL REMOTE COMPUTER
This is where you put the user ID of a remote computer you want to control. The password pops up in a separate box.

4. COMPUTERS & CONTACTS
A list of all the computers in your TeamViewer group. They can chat, video-conference, and share files.

5. RIGHT-CLICK MENU
Right-click one of the computers in your list to see a menu of all the options for interacting with it.

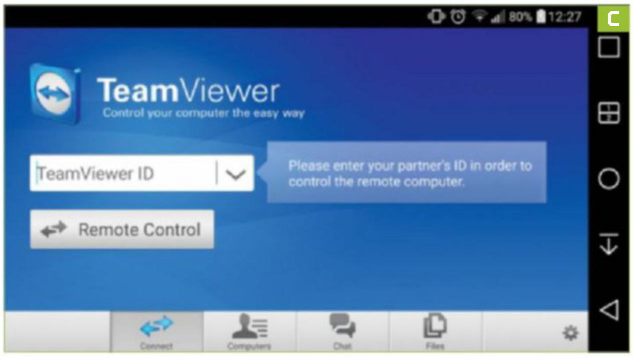
6. NOTIFICATIONS
Notifications for things such as file transfers pop up here in the bottom corner. But not for chats, sadly.

8 VIDEO CONFERENCE

You can use TeamViewer as a video-conferencing facility to hold meetings. Everybody taking part needs a computer with a webcam, and a decent Internet connection. Now make sure the computers you want to include are in the "Computers & Contacts" list, then start a video chat with one, and add the others to it. If you're using TeamViewer for business, though, you do need to buy a license key.

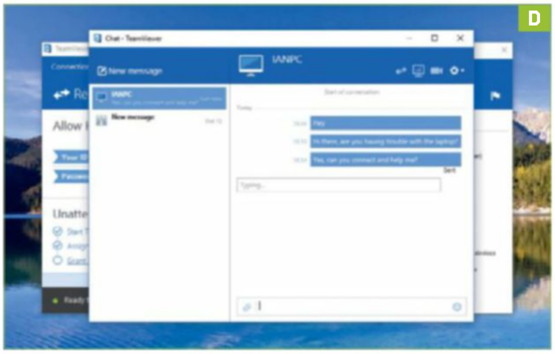
9 FILE TRANSFER

If your team is logged into TeamViewer, they can pass files among one another with the File Transfer functionality. With your connection established, right-click the computer name in the "Computers & Contacts" list, and select "File Transfer" in the menu that appears. The person on the remote computer may have to authorize the transfer, then you can copy files from their hard drive to yours.


C
12:27
80%
TeamViewer
Control your computer the easy way
TeamViewer ID
Please enter your partner's ID in order to control the remote computer.
Remote Control
Connect
Computers
Chat
Files

10 INSTANT MESSAGING

There are more fully featured instant-messaging apps available, but if everyone's logged into TeamViewer, it saves having to use a second app. It's much like any of the other apps, but it doesn't send notifications when someone adds a comment—this means you need to keep the window in view at all times [Image D]. The chat system supports mobile devices, too.


D
Chat - TeamViewer
New message
IANPC
Allow
Unatte
Hey
Hi there, are you having trouble with the laptop?
Yes, can you connect and help me?

BUILD IT

ZAK STOREY, REVIEWS EDITOR

The Ultimate Upgrade

Is this build necessary? Absolutely not? But does it look good? Damn right it does

LENGTH OF TIME: **3-4 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

WINTER IS HERE, the cold dark nights have firmly fixed themselves upon us, and as the bitter chill of the north wind bites into the flesh in those dark and somber hours, it's important to have something to comfort the soul, as we come out of the snow and into the warmth. Something? Well, this is *Maximum PC,* so it has to be a system. In short, the aim of this is to be the ultimate upgrade. After a year of fantastic releases and phenomenal performance increases, our reviews editor decided it was about time he pursued an upgrade of his own. So, what are we upgrading from? Well, at the heart of the system was an Intel Core i7-6700K @ 4.8GHz, 32GB of Kingston HyperX DDR4 @ 2,400MT/s, an Nvidia GeForce GTX 1070, one Samsung 950 Pro 256GB M.2 SSD, and a 1TB OCZ Trion 100 SSD. There are a few other details: The Corsair Hydro H100i GT cooling the CPU is kept chilled by four Noctua NF-F12 iPPC fans, and the power is supplied via a Corsair AX1200i inside an NZXT Manta chassis.

It's a respectable rig. Already quite the powerhouse of technology, but not without its flaws. The fans are too loud, they spin at too high an RPM; the GPU, although powerful, isn't enough to satisfyingly game at 4K; and the Asus Z170i Pro Gaming is having trouble booting from that Samsung PCIe SSD, with load times reaching into minutes in some cases.

The solution to all these woes came from two desires. One, to swap out from a 28-inch TN 4K Iiyama Prolite B2888UHSU (seriously, who thought of that designation?) to a 27-inch IPS 165Hz 1440p AOC Agon AG271QG. And the second to utilize the absolutely stunning NZXT Source 340 Elite chassis.

GLUTTONY AND HARDWARE DECISIONS

FOR THIS BUILD, it was all about keeping it as clean as possible; accenting just the hardware, and drawing away from the cables and anything else cluttering up the interior. To start, we opted for the Asus Z170 TUF Sabertooth motherboard, with a twist. The thermal armor covering the majority of the mobo helps keep it looking slick, but the mid cap, with its chrome finish, is a bit gaudy, so that would have to be plastidipped. Then it was on to the cooling. As the NZXT Kraken X52 had just arrived in the office, it seemed like the obvious choice. For fans, we opted for three of Corsair's ML120 Pros with white LEDs; their super-low RPMs mean they can run whisper quiet, and they look awesome. We had them in a pull configuration on the radiator, purely to ensure we could see some form of movement inside the case itself.

For graphics, we went with two MSI GeForce GTX 1080 Gaming Xs, the same cards we used for the Dream Machine 2016, but running on air, and with one of MSI's HB bridges as well, to give them a little more pizazz, and to put to bed the question of whether or not the HB bridge makes a difference. Memory was provided by four sticks of 16GB G.Skill Trident Z DDR4, and the storage changes came in the form of swapping out the 256GB 950 Pro to a 250GB 960 Evo, and the 1TB OCZ Trion 100 for the now slightly ageing 2TB Samsung 850 Pro 2.5-inch SSD instead.

INGREDIENTS

PART		STREET PRICE
Case	NZXT S340 Elite	**$100**
Motherboard	Asus Z170 TUF Sabertooth Mk1	**$255**
CPU	Intel Core i7-6700K	**$370**
Memory	G.Skill Trident Z 64GB (4x 16GB) @ 3,200MT/s	**$410**
GPU	2x MSI GeForce GTX 1080 Gaming X	**$1440**
PSU	Corsair HX1000i	**$200**
Storage 1	250GB Samsung 960 Evo	**$180**
Storage 2	2TB Samsung 850 Pro	**$850**
Cooling	NZXT Kraken X52, 3x Corsair ML120 Pro White	**$225**
Accessories	2x BitFenix Alchemy LED strips, 2x Silverstone dust filters, BitFenix Alchemy cable kit, MSI HB bridge	**$176**
Total		**$4,206**

1

ALL THINGS COOLING

IT'S THE SMALL DETAILS that matter the most. With limited airflow, we had to be smart about how we installed the setup. By default, the S340 supports up to two 140mm fans in the front, one 140mm fan in the roof, and one 120mm fan in the rear. To ensure we had a positive system, the plan was to install the Kraken X52 in the front of the case, using the two ML120 Pros as intakes, and then only have one ML120 Pro exhausting air out of the back, leaving the top fan empty. The only problem being the excessively open grille letting in dust. To counter this, we opted to grab two Silverstone magnetic dust filters, one for the rear of the chassis and one for the roof. These set us back about $8 each, but are well worth it in the long run.

2

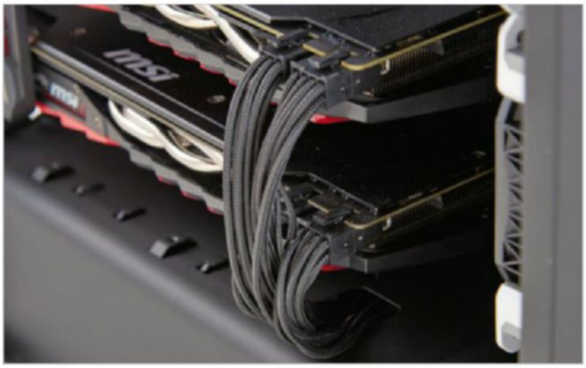
SLI BRIDGES AND YOU

THE NEXT ADDITION to this build was the SLI bridge. Now, we're still not entirely convinced about how much this actually affects performance, but judging by the fact that the Fire Strike scores are slightly higher at 1440p and 4K, we assume it's doing something worthwhile. That said, what it definitely does add is a bit of bling, along with additional support between the two cards, reducing GPU sag in return. The LED lighting, although not controllable, does look pretty swish with the GTX 1080s, and the brushed aluminum finish fits in nicely with our overall aesthetic.

3

CABLING AND CASE MANAGEMENT

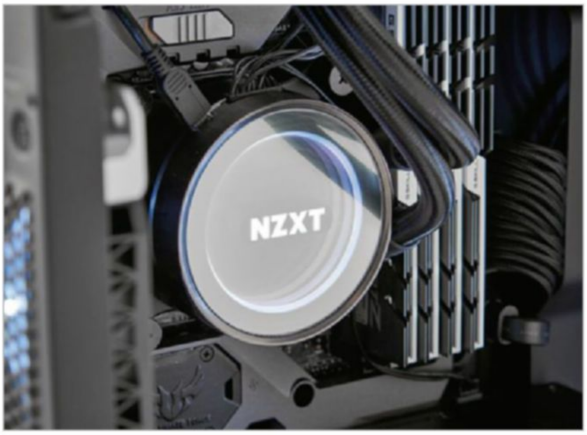
FOR CABLING, we decided to opt for a set of pre-sleeved cables from BitFenix. In fact, we were pretty shocked to discover they sold full kits, but with support for a variety of brands, including EVGA, Corsair, Seasonic, Be Quiet!, and Cooler Master, it was a no-brainer. The original intention was to pop out the ATX pins and fit them with E22 stealth combs, to further smarten them up, but, unfortunately, they turned out to be too tight to remove from the factory fitting—a tutorial for another time, perhaps. On top of that, the S340 Elite comes with fantastic cable routing options, with the SATA SSD mount in the floor (if you're not running two HDDs behind the PSU cover), the GPU power passthrough, and, of course, the giant cable bar running up through the center of the chassis.



4

TAMING THE KRAKEN

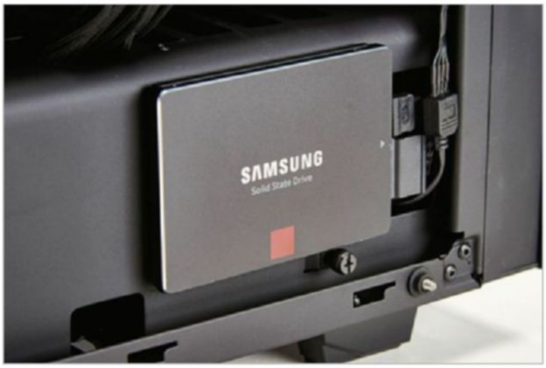
WHAT A BEAUTIFUL PIECE of craftsmanship—NZXT's latest AIOs look stunning. The infinity mirror on the CPU block is nothing short of awe-inspiring, but to run a block like that, in this manner, requires a plethora of cables, including a substantial micro-USB cable, and a proprietary fan/pump cable. These were a little difficult to route. We ended up running the micro-USB through the CPU power cutout, and the rest of the cables into the back of the chassis, to the top-right of the motherboard, before routing them back through to reduce cable slack. The pump header was then carefully weaved around the thermal armor and into the fan header, below the four sticks of DDR4.



5

SSD DECISIONS

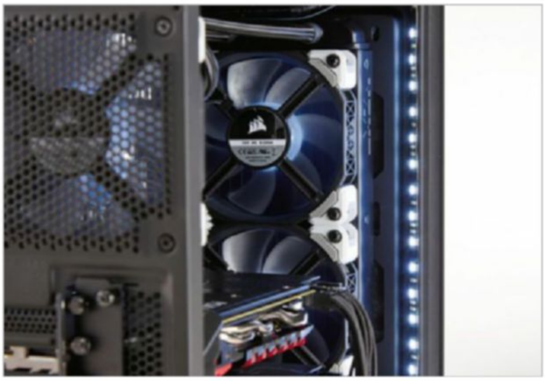
2.5-INCH SSD SUPPORT in the S340 Elite is an interesting proposition. You have three options for placement. You can place one at the front, on the side of the PSU cover, two below the graphics cards, with easy cutout holes for cables to reach through, or two in the hard drive cage, inside the PSU cover. Because we opted to use a 250GB Samsung 960 Evo M.2 drive for our OS, hidden away under our motherboard's armor, we decided on a single SSD on the PSU cover, and removed the additional two SSD sleds below the GPUs, to make it look a little cleaner. We were fortunate with this build in that the two MSI cards, spaced so far apart, successfully cover those two sleds; without them, two empty bays would look a little out of place.

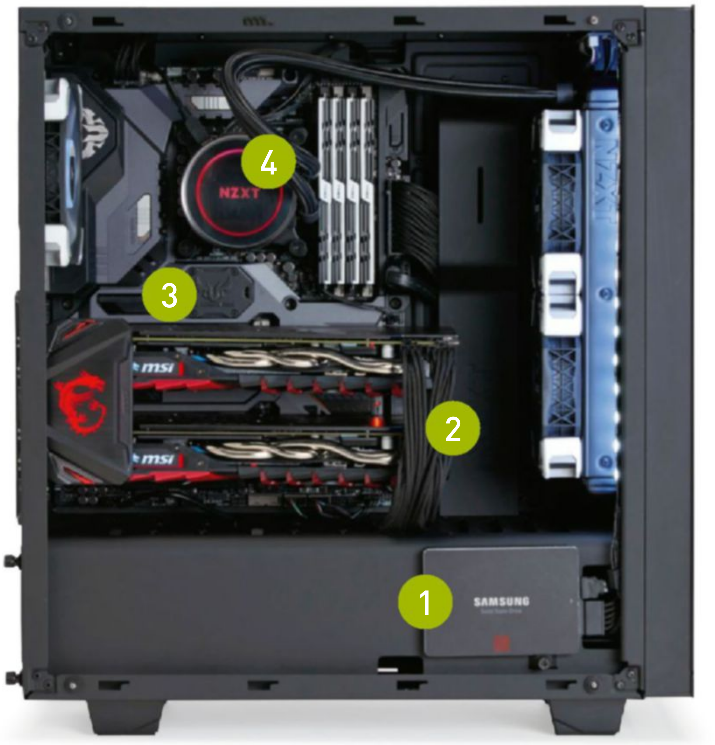


6

LIGHTING PERFECTION

LIGHTING IN THIS BUILD is tricky. We're still not 100 percent sure whether this will be the final configuration, but it does look cool. The general rule of thumb for lighting anything is that the lights themselves shouldn't be seen, but the light they throw should. You can work different angles and highlight different products by utilizing either LED strips or individual LEDs. One thing to note: You should almost always use white LEDs; using any other color LED strips pulls all the color out of your components, and just bathes them in the color of the lights. Also, you need to be smart with your strip purchases. We use magnetic BitFenix Alchemy 2.0 strips in our steel chassis builds, and normal adhesive-based ones in acrylic or aluminum cases.





1 There are two cutouts here for SSD cables; we chose to use the one closest to the front panel, as it meant we could keep our SSD branding the right way up, and the cables out of sight. Unfortunately, it does limit the potential of those two 3.5-inch bays behind.

2 We originally intended to do a bit of a minor mod here, by taking a pre-braided cable kit, popping off the connectors, and fitting them with stealth combs to keep them better aligned. However, they proved to be too difficult to remove, so we opted to run without. A how-to feature coming up soon....

3 The plastidip job we did on the ugly chrome motherboard cover really did the trick. Thanks to the plastic paint covering it, it matches the rest of the build, doesn't look too gaudy, and is easily removable if necessary in the future.

4 The Kraken X52 is certainly a treat to look at. That said, there's something about a 240mm radiator that doesn't sit right with us nowadays. Especially because there are so many well-developed 140mm static pressure fans available, mag levs included.

THE PERFECT, EASY-BUILD, AESTHETIC PC

WE SET OUT TO PROVE that you don't have to go the whole hog to create a stunning-looking system. Things such as liquid-cooling, although coming with their own thermal advantages and aesthetics, aren't the be all and end all of bespoke custom PCs. Yes, the build we have here is monstrous, and comes with a hefty price tag, but its components are, in lots of ways, very similar to those at all ends of the spectrum. GPUs with four-figure price tags often use the same cooler designs as those costing just under $200; the highest capacity memory still fits into the same slots as those two 4GB DDR4 sticks; and so on. Although SLI is limited nowadays to only operating on the GTX 1070 and above, you can achieve similar results with AMD solutions, or even just opt for a single, more powerful card.

For some, aesthetics are a waste of time in computing. After all, it's just a box that's going to end up under your desk, so why care? Because it's something you pour time and money into, something you sit at, often for hours, working, enjoying media, gaming, so why not make the most of it, and take the opportunity to make your system beautiful?

Of course, it does cost more to do something like this, but it could be less than you think. Taking time to route your cables and tidy them up costs nothing. The next step up, a new case, an LED strip or two, and a braided cable kit for your PSU, can come in at less than $200. Add in two or three fans and a decent dual-rad cooler for 300–400 bucks, and you net yourself improved thermals, lower noise, and a system you can proudly display in your home. That's a win in our books.

But enough justification, what about the system? Well, it looks stunning. The Kraken X52 not only looks good, but also keeps the chip cool, with temperatures ranging from 27 C at idle, up to 52 C under load. Corsair's ML120 Pro fans are extremely quiet, the only downside being that the MSI cards can get noisy under load. As a performer, it's quite impressive; rendering performance is snappy, and having access to 64GB of DDR4 makes for exceptionally fast Photoshop work. We're utilizing a 24GB RAM cache to take advantage of all that storage by transferring the browser cache, scratch disk, and temporary system files to it to alleviate load times, among other things. Gaming on older titles is nifty, and although there are a few issues with newer AAA games, it's an exceptionally enjoyable experience at 1440p and above, with frame rates reaching well into the 70s and above.

Is it perfect? Arguably no. There are still things we can tweak: an extra LED or two, better cable routing, and our own custom cables. And, no doubt, the mighty Kaby Lake and a multitude of upgrades lie in its future. But, for now, this reviews editor couldn't be happier, with a well-rounded system to see us through those harsh winter months.

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi-Thread	987	895 (-9%)
Cinebench R15 Single-Thread	196	179 (-9%)
TechARP's X264 HD 5.0.1 (fps)	21.93	19.59 (-11%)
CrystalDisk QD32 Sequential Read	1,895	2,927 (54%)
CrystalDisk QD32 Sequential Write	949	1,538 (62%)
Rise of the Tomb Raider (fps)	76	84 (11%)
Far Cry Primal (fps)	72	82 (14%)
The Division (fps)	42	134 (219%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM.
All games are tested at 1080p on max settings, with HD texture packages installed.

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ASUS
THERMAL ARMOR

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Intel Core i7-7700K

The return of 5GHz

KABY LAKE is eighth processor iteration since the introduction of the Intel Core series that started with Nehalem. For eight years, the company has pressed to push the advantage in its processor lineup, and each and every time it's managed a marginal 10–15 percent performance increase. This process has been, for the longest time, based around the concept of Tick-Tock. In short, a new architecture would be designed based on the latest transistor size, then that transistor size would be shrunk the following year. For instance, Sandy Bridge (or the Core i5-2500K) held the new architecture, while Ivy Bridge (Core i5-3570K), released a year later, was the die shrink, and so on.

However, this hasn't always been the case, and Intel has, time and time again, come up against issues. The first we saw of this was with the Haswell refresh, known as Devil's Canyon, then once more as Broadwell was delayed for around six months—each drop in transistor size becoming ever more difficult for the technology giant to achieve. Fast-forward to the release of Skylake, Intel's first 14nm architecture, and we're greeted with news that Tick-Tock is finally being annexed in favor of a new scheme called PAO, or Process, Architecture, Optimization. In short, the die shrink (originally the Tick) has turned into the Process part; the architecture (the Tock) is now, well, the Architecture; and lastly we also have Optimization. A new piece to the puzzle, where Intel attempts to gain the maximum amount of performance possible from both a mature manufacturing process and a more optimized architecture. On top of giving Intel an additional year to perfect its manufacturing processes, it also gives us another chip.

Ignoring Devil's Canyon, Kaby Lake is the first true Optimization release we've seen, and with it comes a lot of questions. If Intel's generational gains have been so minimal from generation to generation, what on earth can Kaby Lake do to make that any different? Well, that's what we're here to answer.

BENCHMARK BONANZA

Intel's Core i7-7700K is a four-core, eight-threaded, low-power rendering powerhouse. It is, in short, the pinnacle of what Intel has managed to achieve with Skylake and the 14nm technology. With greater performance and better overclocking potential than we've seen from any of Intel's last few generations of chips, it comes packing a whopping 4.2GHz core frequency, turboing up to 4.5GHz with boost. We were immediately impressed with its out-of-box performance. In Cinebench R15, we saw scores planted well into the high 900s, with single-core performance peaking at 194—a sweet little 8 percent increase over Skylake. It was a similar experience across the board.

What really impressed, however, was the overclocking potential. We increased the multiplier up to 48 without the core batting so much as an eyelid, and stock voltages happily keeping the 4.8GHz chip on track. 5GHz came next, needing only a 0.05V increase to the Vcore, with temperatures sitting comfortably at 62 C under our 280mm NZXT Kraken X61. But it kept going, higher and higher, until eventually we topped out at 5.2GHz with 1.4V added to the Vcore—a substantial increase, but temperatures still only sitting at 80 C. This chip runs cool—ice cool, in fact. Stunningly impressive compared to older editions, this is an overclocker's core.

Is it worth upgrading today? Well, that depends on what interests you. Generally speaking, the Z270 chipset is feature-rich, and adds additional support for PCIe devices and such. But in contrast to the change from Z97 to Z170, it pales in comparison. Putting the processors side by side, the difference between Skylake and Kaby Lake is minimal. If you're already set up with the sixth generation of processor, it's certainly not worth your time, unless you're an overclocking fiend after the highest possible performance, with lower temps, and better power draws. Upgrading from Ivy Bridge, Haswell, or Devil's Canyon, on the other hand, is very much worth your time. And we can't recommend this core enough in that regard. **–ZAK STOREY**

VERDICT

8

Intel Core i7-7700K

+ **CRAZY LAKE** Good overclocking performance; comparable to a 6800K @ 5.2GHz; solid performer; Z270 chipset; low power; low temperatures.

− **MAYBE LAKE** Skylake still strong performer; incremental increase is slim.

$350, www.intel.com

BENCHMARKS

	INTEL CORE i7-6700K	INTEL CORE i7-7700K
X265 Benchmark (fps)	18.35	20.68 (13%)
Cinebench R15 Single-Core (Index)	179	194 (12%)
Cinebench R15 Multi-Core (Index)	866	970 (12%)
FryRender Benchmark (min:sec)	4:04	3:45 (8%)
AIDA64 Memory Latency (ns)	62	55.2 (11%)
Power Draw Idle (Watts)	51	44 (14%)
Power Draw Load (Watts)	93	110 (-18%)
Total War: Attila @ 1440p (avg)	40	41 (2%)
Far Cry Primal @ 1440p (avg)	77	77 (0%)
3DMark: Fire Strike (Index)	16,856	17,948 (7%)
Cinebench R15 @ Maximum OC	1,024	1,082 (6%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our test bed consists of an Asus TUF Z270 Mark 1, 8GB of DDR4, a 500GB Samsung 850 Evo SSD, with an NZXT Kraken X61 cooler.

SPECIFICATIONS

Base/Turbo Clock	4.2GHz/4.5GHz
Cores/Threads	4/8
Lithography	14nm
Cache	L3 8MB
Memory Support	64GB DDR4
Memory Channels	2
Max PCIe Lanes	16

Performance is more
than just skin deep.

Asus TUF Z270 Mark 1

Welcome to the era of Z270

WITH ANY NEW CHIP, comes a new chipset. And with each generation, that chipset improves in a variety of ways. The improvements usually revolve around connectivity and expansion support. But there are often other notable tweaks as well, such as aesthetic design, cooling support, and updates and enhancements to the bundled software, so that it works with the latest and greatest hardware.

Asus's TUF Z270 Mark 1, is the first of this new generation of boards that we've been fortunate enough to review. Replacing the Sabertooth pseudonym in favor of the far simpler Mark 1, this is a mobo that should, in every way, follow in its father's footsteps—a reliable workhorse, compatible with all, and capable of keeping up with even the best overclocking boards out there.

Unfortunately, we had trouble from the get go, with memory kits in particular. The TUF Mark 1 was decidedly awkward, only operating with a single stick of DDR4, no matter how much we worked with Asus on trying to remedy the situation. Sadly, this is the type of issue that reviewers often have to deal with, especially when having access to products so far ahead of launch. Asus has assured us that it is working on a BIOS update to fix any potential memory compatibility issues in readiness for launch, and by the time you read this review, all of the TUF Mark 1 motherboards should be up and running perfectly.

Memory troubles aside, what's different in the Z270 chipset compared to last gen? Well, firstly, Intel has included an additional four PCIe 3.0 lanes (going from 20 to 24), to help cater for the ever more aggressive push toward PCIe storage. We additionally have Thunderbolt 3 support (although it isn't included on this motherboard), 10 USB 3.0 ports, allowing for two onboard USB 3.0 headers, and that's about it. USB 2.0 support is the same, Ethernet is the same, even the socket is still the LGA1151, meaning you can insert a Skylake chip in a Z270 board, and vice versa if you so desire.

PERFORMANCE PARITIES

Performance, however, is impressive, and coincides nicely with the new Intel Core i7-7700K processors. We won't know for sure how far we can push our new Kaby Lake successors until the more premium overclocking boards arrive on the scene, but, for the time being, we're more than impressed with what Intel has managed to pull off in conjunction with these Asus boards. Overall, it seems the power-phase design on the VRMs are exceptionally similar between the two review boards we have in. Although performance did vary slightly between the Asus TUF Z270 Mark 1 and the Maximus IX Hero, overclocks and undervolts remained exceptionally similar between them. Noticeable differences occur in overall design, with the TUF featuring a rather interesting vertical M.2 slot, with securing bracket included, located at the bottom of the board. On top of that, the two internal fans designed to shift cool air below the thermal armor are gone. Instead, we're graced with further integration of Asus's RGB phenomenon in the form of AURA lighting, located below the center cap, and a single 40mm fan in the rear, which seems like a missed opportunity, given PCIe SSDs' tendency to thermally throttle themselves. The neat features integrated in the last series of TUF Sabertooth are also still around. The thermal armor is still capable of hiding a full M.2 PCIe SSD, the dust covers and caps are still there, and the board still features a plethora of fan headers and TUF's world-renowned ICe fan controller chip.

The Mark 1 is a solid reiteration on the last generation of TUF motherboards. And although Z270 isn't mind-bogglingly different to Z170, the expanded storage support and reiterated design make it a worthy upgrade, and well worth your time if you're still on any processor prior to Haswell and the Z97 chipset. **–ZAK STOREY**

VERDICT
9

Asus TUF Z270 Mark 1

⊞ **HUNTER'S MARK** Low idle power draw; solid performance; expanded PCIe support; TUF armor; RGB lighting.

⊟ **BLACK SPOT** Single mini cooling fan; lack of second hidden M.2 slot; aesthetics could be improved.

$260, www.asus.com

BENCHMARKS

	Asus TUF Z270 Mark 1	Asus Maximus IX Hero
X265 Benchmark (fps)	20.68	**21.06**
Cinebench R15 (Index)	970	**981**
FryRender (m:s)	3:45	**3:37**
AIDA64 Memory Latency (ns)	**55.2**	59.5
CrystalDisk Sequential Read/Write (MB/s)	549/527	**551/530**
Power Draw Idle/Peak (W)	44/**110**	**43**/126
Far Cry Primal @ 4K (Avg fps)	42	**43**
3DMark Fire Strike Extreme (Index)	**9,522**	9,462
Maximum Overclock Achieved (GHz)	**5.2**	**5.2**
Lowest Undervolt @ Stock (V)	**1.15**	**1.15**
Lowest Voltage @ 5GHz (V)	**1.25**	**1.25**

Best scores are in bold. All benchmarks performed with an Intel Core i7-7700K, 16GB of DDR4 2400 (2x 8GB), GeForce GTX 1080, and a Samsung 850 Evo 500GB.

SPECIFICATIONS

Chipset/Socket	Z270/LGA1151
Form Factor	ATX
Memory Support	64GB DDR4 @ 3,866MT/s
M.2/U.2 Support	2x M.2 PCIe x4
SATA Support	6x SATA 6Gb/s
Max PCIe Support	3x PCIe 3.0 x16 (x16 x8 x4)
Rear I/O	5.1-channel audio, SPDIF-out, 5x USB 2.0, 2x USB 3.0, 1x USB 3.1 Type A, 1x USB 3.1 Type C, 2x 1Gb/s Intel NIC, HDMI 1.4(b), DisplayPort 1.2

THERMAL ARMOR
Z270
THE ULTIMATE FORCE
ASUS

Our first taste of the new chipset for the new chip.

Origin PC Chronos

Small but mighty

THEY SAY GOOD THINGS come in small packages. That certainly is the case when it comes to the Chronos from Origin PC, a supremely powerful system in a very small chassis. Measuring just 11.75 x 13.75 x 4 inches, the Chronos is one of the most compact systems we've ever tested. And considering that size, and the power it packs inside, it just might be worth its super-premium price tag.

Of course, a big price tag should mean top-end performance, and the Chronos does not disappoint. The system we tested was outfitted with the enthusiast-class Intel Core i7-6950X sitting in an ASRock X99 ITX motherboard. The 6950X's 10 cores clocked at 4.1GHz helped the Chronos blow away our zero-point in Cinebench R15 and TechARP's x264 benchmarks.

For storage, our Chronos featured a 512GB Samsung 950 Pro M.2 SSD, combined with a 6TB Western Digital Red HDD. Remarkably, Origin says the system can fit up to four 2.5-inch SSDs, but we can't for the life of us figure out where. The inside of the Chronos is packed tighter than an overflowing suitcase—not surprising, considering it sports a full-size GeForce GTX 1080 GPU.

Here at *Maximum PC*, we often get spoiled by crazy high-end systems, making it easy to forget that the GTX 1080 is an impressively powerful graphics card. While the Chronos can fit up to a GTX Titan X inside, the 1080 in our system is more than capable of handling high-demand gaming situations.

The Chronos boasted an average of 125fps across *Rise of the Tomb Raider's* three-part GPU benchmark in 1080p at max settings. *Far Cry Primal* and *The Division* produced similar results from their benchmarks—around 102 and 95fps respectively. More impressively, the Chronos performed well at higher resolutions. *Rise of the Tomb Raider* showed 84fps at 1440p, and 47fps at 4K. And through several hours of *Titanfall 2's* campaign at 1440p, we don't recall the frame rate ever dropping below 80fps, even in the most frantic firefights.

WHAT'S IN A CASE?

A large selling point for the Chronos is its custom-built chassis, made from server-grade steel. It's small, sturdy, and can be outfitted with a custom paint job in the pattern or color of your liking. However, packing that much power into such a small case does come with a few caveats.

The Chronos's Frostbyte liquid cooler keeps the CPU at a reasonable temperature, considering there's little room for airflow inside the cramped quarters. However, take care if you ever need to open the case up and look inside. When we reassembled our Chronos, the liquid cooler tubes blocked the radiator fan from spinning unless they were positioned just so. Origin, of course, should ensure the tubes are properly situated, but it's something to think about should you ever need to open the case for a routine dusting.

Overall, the Chronos is an impressive system in a very small frame. And thanks to its detachable magnetic feet, it can sit in any orientation on or under your desk. We recommend proudly displaying the beastly GTX 1080 through the LED-illuminated viewing window. Of course, it's not cheap, but that's the price for a top-tier build. **–BO MOORE**

BENCHMARKS

	ZERO-POINT	
Cinebench R15	987	2,128 (215%)
Tech ARP x264 (fps)	21.93	42.61 (94%)
CrystalDiskMark 4K Read	54.85	50.61 (-8%)
CrystalDiskMark 4K Write	171	183.03 (7%)
Far Cry Primal (fps)	76	102 (34%)
The Division (fps)	78	95 (22%)
Rise of the Tomb Raider (fps)	41	125 (304%)
3DMark Fire Strike	15,026	18,506 (23%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point has a Core i7-6700K overclocked to 4.6GHz, an XFX Radeon R9 Fury X, 32GB of Kingston HyperX Savage DDR4-2400, and a 256GB Samsung 950 Pro, mounted on an Asus Z170i Pro Gaming mobo.

VERDICT
9

Origin PC Chronos

+ CHRONOMASTER Powerful; small; quiet; lots of SSD bays.

− TIME OUT Precarious cooler tubes; very expensive.

$5,058, www.originpc.com

SPECIFICATIONS

CPU	Intel Core i7-6950X @ 4.1GHz
Graphics	8GB Nvidia GeForce GTX 1080 Founder's Edition
RAM	16GB (2x 8GB) HyperX Savage DDR4
Motherboard	ASRock X99 ITX
Primary Storage	512GB Samsung 950 Pro M.2 SSD
Additional Storage	6TB Western Digital Red
Cooling Solution	Frostbyte 120
PSU	600W Corsair SFX Series
Case	Origin PC steel case
Warranty	Lifetime 24/7 US-based support and lifetime free labor; three-year part replacement and free shipping warranty

The Chronos runs surprisingly quiet, considering how little room there is for airflow.

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Adata XPG SX8000 512GB

A consistently inconsistent SSD

ZEROES AND ONES, that's all there is to computing, right? Theoretically, yes. In practice, things are a bit more complicated. Enter Adata's new XPG SX8000 SSD.

Such are the complexities of SSD tech, the SX8000's headline specifications are little more than a stepping-off point for what the drive actually delivers. It's still an intriguing SSD on paper, of course.

For starters, it uses Intel's hot (in more ways than one) new 3D MLC NAND flash memory. Feeding those memory chips is Silicon Motion's SM2260 controller. It's a full-featured item with two ARM Cortex cores, eight NAND flash channels, and low-density parity check (LDPC) error correction. More on that in a moment.

In terms of form factors and interfaces, we're talking M.2, quad-lane PCIe, and, naturally, the NVMe control protocol. A thoroughly modern SSD. Adata pegs the SX8000's sequential read performance at up to 2,400MB/s, and its write performance at 1,000MB/s when pseudo-SLC caching is used. As for random performance, the new drives can deliver up to 140,000 4K read/write IOPS. Those figures are for the 512GB model here and its 1TB sibling. The 128GB and 256GB options are significantly slower.

Back to LDPC. Some would argue that it's old technology wheeled out to claw back some endurance from the write cycles of Intel's 3D MLC memory. Meanwhile, the SX8000 is partially dependent on caching technology to achieve its peak speeds—not always great for real-world performance.

With all that in mind, what can we tell you about the SX8000's performance? It's complicated. Following our setup routine, which involves brimming the drive with data before wiping it clean, the numbers were hideous. Actually, scratch that. We could see this drive had a few issues even during the setup process. The SX8000 was clearly cycling through performance states, most likely as a consequence of filling, then flushing that pseudo cache.

TESTING TRAGEDY

Diving into the benchmarks, it wasn't getting anywhere near the claimed numbers, and dropped as far as 600–700MB/s for sequential reads and writes. Things didn't look any rosier in our real-world file transfer and compression tests. Over four minutes for our 30GB internal file copy test is nothing short of tragic. Left overnight to idle, however, and the SX8000 performed much, much better.

Peak sequentials of 2,291MB/s and 946MB/s for reads and writes respectively in CrystalMark are pretty much on the money, for instance. It returns some very nice looking numbers in AS SSD's 4K random access benchmarks, too.

But here's the catch. Not only is Samsung's latest solid-state killer, the 960 Pro, capable of much faster performance in most tests, but even after being left to idle, and thus allowing the Adata's garbage collection routines to do their thing, performance still remains inconsistent.

Very likely, much of this comes down to the properties of NAND flash and its need to be written in blocks, rather than being addressable at bit level. Judging by how hot the drive gets to the touch, it's possible that thermal throttling is partly to blame, too. Either way, most SSDs now do a good job of compensating for the shortcomings of flash memory. For all the wrong reasons, the SX8000 is a reminder of how far flash memory has come, and how complex it is to implement in a high-performance, small-form-factor SSD. **–JEREMY LAIRD**

VERDICT

6

Adata XPG SX8000 512GB

⊞ **WARP DRIVE** Solid feature set; competitive pricing.

⊟ **CORE FAILURE** Patchy performance; likely limitations to pseudo-cache tech; runs hot.

$280, www.adata.com

BENCHMARKS

	Adata XPG SX8000 512GB	Samsung 960 Pro 2TB	Samsung 950 Pro 512GB
Atto Sequential Read/Write (MB/s)	1,109/951	**3,420/2,099**	2,624/1,532
CrystalMark Sequential Read/Write (MB/s)	2,291/948	**2,636/2,077**	2,210/1,539
CrystalMark 4K Read/Write (MB/s)	30/160	**57**/194	51/**198**
5GB Zip (Seconds)	205	196	**193**
30GB Copy (Seconds)	99	**41**	43

Best scores are in bold. Our test bench consists of an Intel Core i7-6700K, MSI Z170A Gaming M7, and 16GB Crucial Ballistix Elite DDR4-2666.

SPECIFICATIONS

Capacity	512GB
Interface	M.2 PCIe x4
Control Protocol	NVMe
Controller	Silicon Motion SM2260
NAND Type	3D MLC
Sequential Read/Write	2,400/1,000MB/s
Read/Write IOPS	100/140K
Warranty	Five years

ViewSonic has packed the VP2468 with pro color features.

ViewSonic VP2468

A pro panel for a puny price?

TWO HUNDRED AND FIFTY BUCKS. That's all you now need to stump up for a 24-inch, Full-HD, IPS, multi-input, fully-adjustable PC monitor. Prices really have tumbled over the last five years.

If that's the new norm, it's also the highly competitive context in which ViewSonic's latest, the VP2468, must strut its stuff. The good news is that its feature set does indeed go a little beyond that norm. For the record, it begins with the aforementioned IPS panel and its 1920x1080 pixels. Inevitably at this price point, it's almost certainly a 6-bit-per-channel panel in hardware terms, and uses dithering to achieve the claimed 16.7 million colors.

However, the VP2468 also supports 14-bit 3D look-up tables, plus six-axis color adjustment functionality. Both are a little unusual for this class of display, and elevate the VP2468's utility beyond the budget-monitor masses. Its static contrast, meanwhile, is rated at 1,000:1, the maximum refresh at native resolution is 60Hz, the backlight is a simple white LED affair, and max brightness is 250cd/m^2. If all that, bar the color management stuff, is pretty much par for the course, ViewSonic has also thrown in a decent array of input options, including two HDMI inputs, both full and mini DisplayPort connectors, and a DisplayPort-out for daisy chaining. Nice.

But if there's anything that really makes the VP2468 stand out physically, it's the bezels. There are numerous affordable monitors with slim bezels on three sides. But the VP2468 ups the ante to all four. In other words, it lacks the big, fat chin of most slim-bezel designs. The result is a pleasingly minimalist design, and one that looks conspicuously compact for a 24-inch panel. The fully adjustable stand with swivel, rotate, tilt, and height tweakability is a welcome inclusion, too.

All of which just leaves the minor matter of how this display performs. The VP2468 is pitched as a cheap solution for professional applications, and with that in mind, each panel comes factory calibrated, complete with a printout of the results, and a promise that all color deltas are below two. The upshot is a nicely set-up display, with excellent detail in both black and white scales. As you'd expect from an IPS display, the viewing angles are excellent, too.

Another plus point concerns the two-tier OSD menu. With both a simple menu for frequently used settings and a fuller option that includes more settings, it's extremely pleasant to use. The only obvious omission is an option for adjusting the pixel overdrive. Handily, that brings us to the first of the VP2468's image quality issues. The pixel response is mediocre. Worse, there is occasionally some fairly obvious inverse ghosting with certain colors and shapes. As if that isn't enough, the likely fact that this is a cheap 6-bit IPS panel is all too obvious when viewing color gradients. The tell-tale banding is, sadly, clearly evident.

We're not crazy about the contrast, vibrancy, and colors, either. We had a 4K TN monitor running in parallel during our review process, and it had this ViewSonic comprehensively beaten for subjective contrast and color vibrancy, which goes to show you shouldn't always base your buys on panel type. The comparison also highlighted a lack of punch from the backlight, and a slight dirtiness to the quality of the white tones. It's not the purest, whitest panel you could wish for.

Of course, this is an affordable $250 screen, it has a strong feature set, and its shortcomings are largely generic. Cheap 6-bit IPS panels aren't pretty. If you need the special features the VP2468 offers, most notably the 14-bit 3D look-up tables and six-axis color controls, it may make sense at this aggressive price point. For everyone else, we advise throwing a few more dollars at your display. **–JEREMY LAIRD**

VERDICT
7

ViewSonic VP2468

+ WHAT A VIEW Strong feature set; slick slim-bezel design; affordable option for graphics pros.

– WINDOWS VISTA Mediocre pixel response; lacks contrast and vibrancy; slightly dirty backlight.

$250, www.viewsonic.com

SPECIFICATIONS

Panel Size	24-inch
Native Resolution	1920x1080
Panel Type	IPS
Maximum Refresh	60Hz
Response	5ms
Display Inputs	2x HDMI, 2x DisplayPort
Connectivity	USB 3.0
VESA Mount	100 x 100mm
Warranty	Three years

Logitech C922 Pro Stream Webcam

Cut out and weep

LET US WASTE NO TIME and begin by addressing the elephant in the Logitech C922 room: its box-vaunted background replacement feature. This is meant to do a virtual chroma-key, and blot out everything but yourself, making this (in theory) a perfect cam for cost-conscious streamers. Using a piece of third-party software called Personify Chromacam, which appears as a virtual device in any webcam-compatible software, whatever happens to be behind you is indeed excised—but it's done with the ferocity and finesse of an angry toddler carrying a chainsaw.

Testing the feature on a busy background, Chromacam routinely hacked off our headphones, and the majority of our arms and shoulders, with strange, wobbling, wavy edges. Sitting stock still and giving it time to adjust just made the problem worse, because it then presumed we were part of the background. If you're interested in holding video conversations looking like a digital ghost struggling to traverse the barrier between the human and spirit worlds, more power to you; the ironic thing is that, in order to get even mildly good results out of it, we needed to move to a spot with a neutral, plain background that contrasted with our clothes and skin. Isn't that precisely what the feature is supposed to prevent you having to do?

Background replacement isn't this cam's only automatic feature, though, and the rest of it is really rather good. Autofocus works very well, reacting quickly to distance changes in the central portion of the camera's viewing area, though the edges, with no way to select a particular focus point, are less sensitive. There's a massive focal range, so it captures you nice and sharp wherever you happen to be sitting. The camera's automatic low-light correction is also pretty good, a step above the integrated webcams we tested it against. Although, as is usual for digital sensors, there's a notable increase in visual noise as the sensor has to work hard to fight the dark. This is an environmental feature more than anything, in that it's helpful if you're in an inconsistently lit locale—next to a window, for example—but less so if you're in an electric-lit room. Taking control manually using the bare-bones settings panel, you get access to a limited set of exposure levels, so you won't always find the perfect configuration.

STREAM DREAM?

There's also panning, tilting, and zooming integrated into the driver—these aren't physical functions, but they're useful if you're a little further away from the camera's massive 78° field of view, and want to crop out your boyband posters and dirty laundry. With its maximum resolution of 1920x1080 at 30fps (and a far zippier 1280x720 60fps mode available) tied into some remarkably sharp H.264 compression, the C922 gives you plenty of wiggle room, in most cases, to work with a smaller area of the image when streaming or holding conversations. Its integrated mic is, well, fine—not something we'd ever record with, and the usefulness of stereo mic functionality in a unit you'll primarily use for Twitch or Skype is debatable. But adding an environmental mic to a desktop PC that lacks one, or upgrading that of a cheaper laptop, is a bonus. You're not short of positioning options, with a desk tripod in the box, and a stiffly-engineered monitor hook that can be adapted to hang from the top of just about any screen, so it's flexible enough for most potential setups.

The main issue with the C922 isn't its failed chroma-key gimmick or slightly awkward settings panel, though. We're utterly spoiled by the devices we have in our pockets, and while phone sensors are improving rapidly, the same can't be said for the sensors we get to play with on the desktop. This is functional and sharp—perfect, in fact, if you just want a webcam—but it's time for the tech, particularly at this price, to take the next step. –**ALEX COX**

VERDICT
7

Logitech C922 Pro Stream Webcam

+ WEBCAM High resolution; sharp video; automated features; stereo microphone.

− FLIMFLAM Terrible background replacement; unremarkable results.

$100, www.logitech.com

SPECIFICATIONS

Recording Resolution	1080p (30fps), 720p (60fps)
Connection	USB
Cable Length	5.9 feet
Compatible Software	XSplit (license included), OBS, Skype, Hangouts, et al
Warranty	Two years

Future

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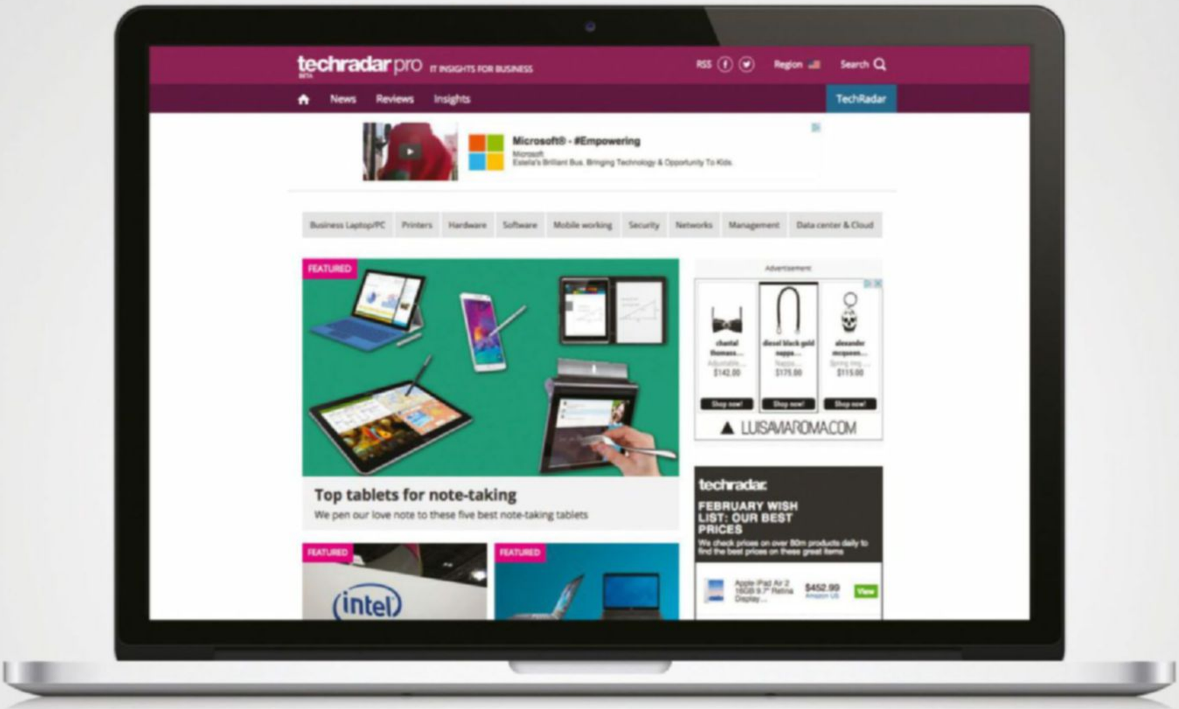
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HyperX Cloud Stinger

Budget cans stripped to the bare essentials

HYPERX HAS BEEN doing some brilliant things in the enthusiast sector. Its RAM is super-fast, its storage solutions pretty much perfect, its keyboards clacky and colorful, and its headsets—particularly the Cloud II—market-leading examples of comfortable audio pleasure. The Cloud Stinger isn't meant to sit in the same niche, though, coming in at literally half the price of its big brother. But you wouldn't know it, at least initially, because this is a neat set of cans, well shaped, and sporting HyperX's signature memory foam earcups. The headband is roomy and well cushioned, the metal adjustment arms stiff and unmoving, unless properly teased, and from them dangle 90-degree rotating earpieces, useful (we presume) if you happen to have a head designed by Pablo Picasso. Or if you want to place the Stinger flat on your desk. Put this super-lightweight closed-cup headset on, and no matter how angular your skull may be, you will not be disappointed with the fit.

Closer inspection, however, reveals the greasy fingerprints of corners cut. The four-pole jack cable is a pathetic 4.2 feet long, although clicking it into the included dual three-pole adapter rounds the length up to a more reasonable 9.8 feet—if you're stuck with a single audio port on your machine, be sure to pick up an extension. Give the faux-leather cup covers a light tug, and that silky cladding moves, and comes away slightly. It doesn't appear to be attached particularly well to the body of the headset—it seems to be glued to the foam—and we could imagine it working its way loose after extended use. There's discrete on-ear volume control, which is always a nice feature, but this slightly sticky slider isn't exactly super-useful, jumping as it does between moderately quiet, mildly loud, and utterly tinnitus-inducing, with little to no nuance in between. Our Stinger also had an unpleasant quirk: Use the slider to drop the volume beyond a certain point, and the right ear audio drops out. This could be an isolated glitch, or it could be a common flaw.

Again, this is a headset that hits a highly reasonable price point. It's not unreasonable to expect greatness from HyperX, but we would be churlish to judge the Stinger against its godly sibling when that's not really its competition—if you have $100 to spend on a headset, there's a world of hardware out there that is actively better than this. But if you have $50 to spend, the Stinger will quickly convince you to forget (or work around) those few flaws. Its 30 ohm 50mm directional drivers bang out a perfectly pleasant soundscape, which, while lacking a little warmth in the middle and vocal ranges, won't leave you thinking you've underspent on sound. Bass noise, as is common with gamer-leaning headsets, is thick and boosted, though not to the point of rattling or distortion, and not so much that the treble end of the spectrum doesn't crack through in a satisfying way.

NOISES OFF

The earcups do tend to be a little leaky as soon as you edge above mid-volume, and the high sensitivity of the condenser microphone makes it all too apparent when you're listening to music while on a call or stream—noise canceling it may be, but extreme metal canceling it ain't. Placed low toward the neck or higher toward the cheekbone, it's a keen enough mic to capture clear conversation without any unpleasant breathing noises, and moving it to vertical mutes it by completely cutting the mic connection to your PC. Handy, although certain soundcards might not like this method.

So, HyperX has cut corners, but it's cut them in the right places. The Cloud Stinger feels comfortable, it sounds pleasant, it has a pretty awesome mic, and it's a fine starter headset. It's fundamentally not as good as things that cost twice the price, but this is an argument we could make forever about everything. **–ALEX COX**

VERDICT 7

HyperX Cloud Stinger

+ **STING** Warm sound; quality mic; lightweight; very wearable.

− **STINK** Iffy volume slider; budget construction; leaky cups.

$50, www.hyperxgaming.com

SPECIFICATIONS

Driver Type	50mm dynamic
Impedance	30 ohms
Frequency Response	18–23,000Hz
Design Style	Closed back
Microphone Type	Condenser, noise canceling
Connectivity	4-pole/3-pole jack
Weight	9.7oz
Cord Length	4.2ft/9.8ft (with 3-pole extender)

Mionix Naos QG

Watch how you play, as you play

WE'RE IN AGREEMENT with Mionix when it comes to the mouse market: It's stagnating. It's nothing more than a gently flowing stream, producing slightly different iterations of the same product each and every year. There's no innovation. Nothing new, nothing truly interesting.

Perhaps the mouse has reached its end goal. Perhaps there is nothing more to do but reiterate on the design. Mionix doesn't think so. The Naos QG is the first mouse we've seen since the introduction of the laser sensor—which shifted away from the unwieldy ball—to truly rethink what you can do with the wily peripheral. Indeed, a heart rate sensor and GSR (galvanic skin response) sensor hardly seem like obvious additions, but the more you think about it, the more they make sense.

Consider being able to track your heart rate while you're using your computer, directly linking and synching programs up with it. Whether that's for health reasons, or purely for entertainment, it's an interesting concept. Link a game to a heart rate sensor, and you could have it react according to how you're behaving. Take a horror title, for instance. Things becoming a little too intense? Knock it down a notch. Feeling calm? Send more jump scares. Obviously, that could become a little dangerous for the end user in terms of potential health issues....

The Naos QG comes loaded with these sensors: one IR-based heart rate sensor to the left-hand side of your right palm, and the GSR to your right. It's certainly an experience—with an Overwolf overlay on screen, you can see your heartbeat displayed as you play or wander around your desktop. In game, it is somewhat unnerving to see how your body reacts. As your hairs stand on end due to the terrifying scenes held within each title, the mouse detects the changes, and vast spikes running along the outside of the edge of the overlay make it painfully apparent that you're somewhat ruffled. Those watching can immediately tell. And that brings us to who this was initially designed for: streamers and content creators. It adds another layer for the audience to view your reaction, another way for them to see how you respond in those often terrifying player experiences.

NICE MICE?

That aside, this is still an ergonomically well-crafted tool. For right-handers only, unfortunately, the Naos supports your ring finger and pinky, nestling you into place naturally. It's big—bulkier than the Castor—but still feels quick and agile enough to ping even the most graceful of headshots into the skull of your opponent's avatar. The RGB lighting is there, of course, along with the other features you'd expect from any mouse, including adjustments to polling rates, DPI, and lift-off sensitivity. Alongside that, the Naos has a soft-touch rubberized gray finish, making it resistant to grease and sweat, while still providing you with an intriguingly different non-black/white device—it's a subtle color, almost looking as though it's still in its initial concept phase.

Is it flawless? No, not on your life. The software is still in its infancy, and the heart rate sensor is jittery. Sometimes, you go from 70bpm to 150bpm, even while on desktop, with little to no explanation, even after removing your hand from the mouse. Other times, it registers your heart rate at 40bpm. It's not frequent enough to make it a particularly frustrating issue, and no doubt it'll be something that's ironed out in firmware and software updates, but it is still a concern.

Is this a good mouse? Yes, very much so. It's currently targeted at a very niche audience, but as it is somewhat of an open standard, with a set of open APIs, it may very well be something that we see a lot more of going forward. And that's no bad thing in our book. –**ZAK STOREY**

VERDICT 8

Mionix Naos QG

⊞ **PANTHEON** Intriguing new concept; potentially revolutionary; ergonomically crafted; great mouse.

⊟ **BASILICA** Jittery sensors; larger than normal mice; primarily palm grip support; pricey.

$130, https://mionix.net

SPECIFICATIONS

Sensor	Optical
Sensitivity	12,000 dpi
Sensor Model	Pixart Technologies PMW3360
Polling Rate	1,000Hz
Programmable Buttons	7
LEDs	One zone—16.8 million colors
Cable Length	6 feet

HyperX Alloy FPS

Minimal keyboard produces maximal noise

FROM A CERTAIN DISTANCE, mechanical keyboards all start to look the same. They're generally matte black, have the same number of keys that are about the same size, and sit on the same switches. Everything has anti-ghosting and N-key rollover, so you can press more than one key at once, and not worry about keystrokes not registering.

This means that you start to look at features, such as programmability, additional macro keys, and a board's more general levels of usability—as well as its looks—to decide what to buy. There's brand loyalty to consider, too, with a desk packed with Corsair products more likely to attract another.

Where does that leave a brand such as HyperX? A division of Kingston Technology, known for its memory products, HyperX has been around since 2002, and sponsors 20 pro gaming teams. With manufacturers desperate to make you think that buying their product will transform you into a professional *Counter-Strike* player, a little pedigree goes a long way.

We mentioned looks earlier, and the Alloy delivers on that score. It's a minimal keyboard, with a small footprint (something the promotional material plays up amusingly, suggesting this makes it ideal for FPS players, who presumably have smaller desks than those who prefer RTS), and a flat backboard with a steel frame underneath, upon which the keys stand proudly to attention, like a well-regulated militia. From the right angle, they can appear to float above the base; black trees sprouting from blue trunks.

That's right: blue. While the Cherry MX Red switch has become almost ubiquitous in recent mechanical keyboards, as the various manufacturers all strive to prove that their keys are the fastest to the floor in the kind of race to the bottom that's led to many models feeling the same, HyperX has installed the Blue switch. The one that clicks. And, by the gods, it's glorious. Using the Alloy at any speed sets up a fantastic racket, as each switch adds its own voice to the tumult. *Maximum PC's* official review wife actually came to see what we were doing, intrigued by the noise we were making.

BLUE GENES

Every single key is mounted on a Blue switch, which means you get as much clicky feedback from Printscreen as you do from W. They also light up, and HyperX has taken the commendable decision to stick to one color—in this case, red. A little more care could have been taken in the positioning of the LED beneath the key, though (it's just above the switch stem, in a little curved cutout, so HyperX has at least tried to mitigate the issue), because while the $ lights up nicely, the 4 beneath it is markedly dimmer. Most keys have their cutouts at the top of the cap, allowing the light to shine through in the optimum way, so it's only on those with a double row of cutouts that this is noticeable.

The lighting is controlled with the Fn key and the arrow keys—there's no software for this keyboard, which also means no programmable buttons. What you do get in the box is a set of replacement keys for WASD, a key removal tool, a bag to keep the keyboard in at night, and the double-headed USB cable that supplies extra power to the board for the phone charging port. This is certainly a nice addition, but why it couldn't have been a full-fat USB 3 port ready to stick a flash drive in, we just don't know.

HyperX has created something great here. The Alloy is fantastic to use, the steel frame adding weight to the base without taking up unnecessary space, and the Blue switches bringing the fun back to keyboards. The lighting is just enough, and while the lack of programmable keys grates a bit, there are enough media functions and other features—such as full anti-ghosting and rollover—to take the edge off our pain. **–IAN EVENDEN**

VERDICT 9 KICK ASS!

HyperX Alloy FPS

+ ALLOY Weighty steel frame; great Blue switches; nice minimal design.

− ANNOY USB port for charging only; lack of programmability.

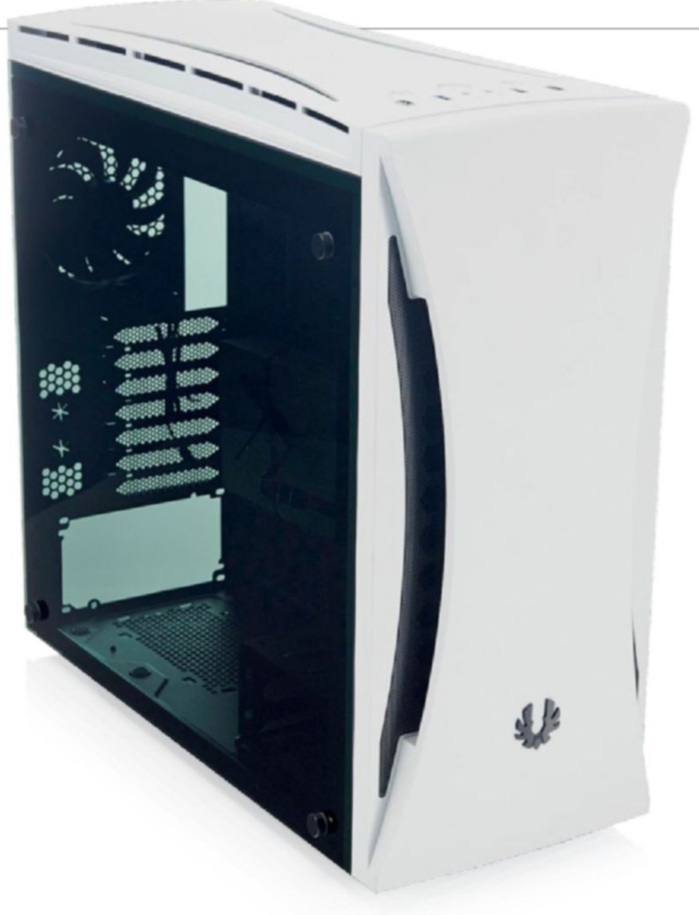
$100, www.hyperxgaming.com

SPECIFICATIONS

Switch Type	Cherry MX Blue
Form Factor	Full-sized
Media Keys	Integrated
Macro Keys	None
LEDs	Red
N-Key Rollover	100%
Passthrough	USB power only
Dimensions	17.4 x 5.1 x 1.4 inches
Warranty	Two years

BitFenix Aurora

Time to get funky



CASE DESIGN has always been a challenging field for manufacturers to excel in. But that's understandable—after all, the number of variables involved is vast. There's material choice, build quality, internal layout, ease of access, included accessories, shape, size, price, and even logo and brand design. All of which affects how consumers view a case.

But, as more and more money is pumped into R&D labs across the case spectrum, the art has almost been perfected, to the point that innovating in this particular subsector of the industry has become unbelievably challenging. It's not hard to find cases that look stunning for less than $100 now. Go back three or four years, however, and the chassis ecosystem was almost unrecognizable, with the only heavy-hitting top-sellers emanating from the foundries of Corsair and BitFenix.

So, here we are in 2017 with BitFenix's latest Aurora chassis. This amalgamation of soft plastic, steel, and tempered glass certainly is eye-catching. The shape alone is enough to turn heads—not in a "wow!" kinda way, but more like that odd facial expression your dog gives you when you make a high-pitched whistle noise. The not-so-subtle curves cut out of the front and top exterior panels add a strange aesthetic to the tempered glass chassis, allowing plenty of airflow into the ventilated front panel, without being too obvious about it. There's a subtle nod given to both the Prodigy and the Shinobi chassis that predate this aggressively designed case. Will it be to everyone's fancy? Perhaps not, but the design does slowly grow on you.

The tempered glass panels, now commonplace in the industry, sit snug against the Aurora. The smoked side, which reveals all your internal components, cries out for solid internal lighting, while the rear panel is entirely blackened, retaining the look and feel of glass, without showing off the undoubtable mess of cables you have tucked away in the back.

That aside, the chassis as a whole follows BitFenix's traditional aggressive modular design. Both of the 3.5-inch drive bays are entirely optional, with the upper cage mimicking a 5.25-inch cage, easily removable with the release of four separate screws, one on each side, and two in the front.

IT'S A TRAP!

There's no hint of a PSU cover just yet from the German manufacturer, but that's not to say the Aurora is devoid of features. The two recessed radiator mounts located in the front and the roof of the chassis are neat little additions, adding a little extra room, and helping to show off your fans through the case window. The support for full E-ATX motherboards, coupled with three 2.5-inch bays, is nice as well. And we also have to mention the oddity of the front-facing LED SSD mount. It's Asus Aura-ready, so that if you want your SSD to light up the same color as your motherboard, you can do that.... Yeah.

All in all, it's an intuitively designed chassis, coming in at a respectable $100. It's not the most modern out there, nor does it offer the most features, but it's well rounded and provides a solid base for any PC builder. It does have its flaws, however—we wish the soft-touch finish, often associated with BitFenix cases, had made its way to the Aurora, and that there was an integrated PSU cover. The design is also a little outlandish, but in an industry that's struggling to define itself outside of six rectangular panels, we can easily understand that. **–ZAK STOREY**

VERDICT
7

BitFenix Aurora

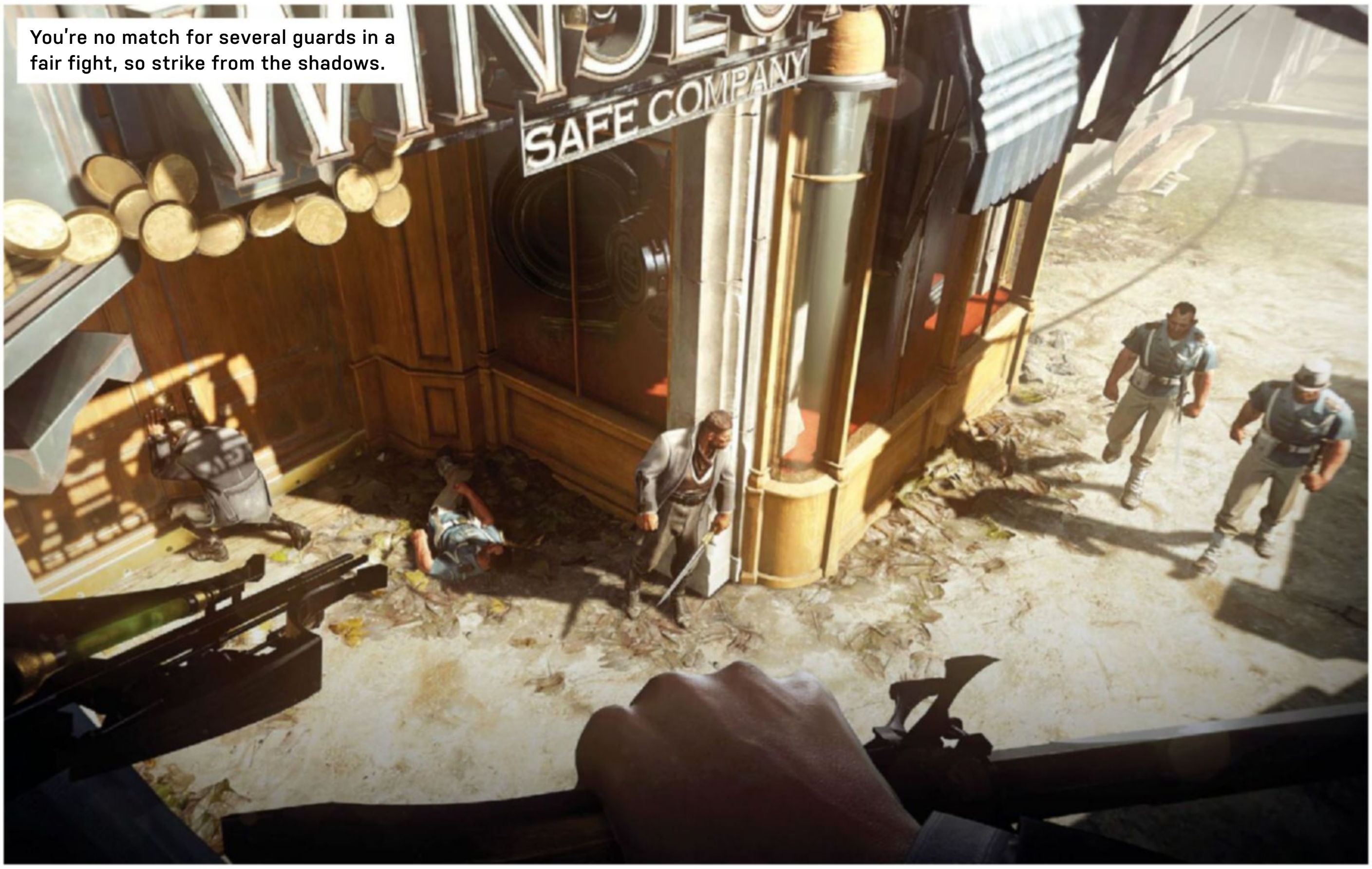
➕ **AURORA BOREALIS** Intuitive radiator support; internal SSD LEDs; tempered glass panels; minor modularity.

➖ **RGB LEDS** Slightly outlandish design; price a little too high; no PSU cover; no soft-touch finish.

$100, www.bitfenix.com

SPECIFICATIONS

Form Factor	Midi tower
Motherboard Support	Mini-ITX, ATX, microATX, E-ATX
Colors Available	Black, white
Window Available	Yes
3.5-Inch Support	4
2.5-Inch Support	3
Radiator Support	280mm front, 280mm roof
Fan Support	2x 140mm front, 2x 140mm roof, 1x 120mm rear
Dimensions	8.5 x 19.3 x 20.5 inches
Graphics Card Clearance	15.7 inches
CPU Tower Clearance	6.3 inches
Weight	26lb


You're no match for several guards in a fair fight, so strike from the shadows.

Dishonored 2

Sneak and destroy

A GAME WITH a distinctive art style is a rarity in these days of potato-faced motion capture, and *Dishonored* has always been so very distinctive. Snarling frowns and raddled complexions stare out at you from every NPC, while the architecture you scurry across is as much a part of the game as the thin faces of the main characters.

For this sequel, Arkane is offering a choice. You can have more of the same, in a game full of references to things that have gone before in the first title and its DLC. Choosing to play as returning royal protector Corvo opens this up, his suite of powers familiar, but now able to be upgraded beyond anything the previous game offered.

A different way of playing is offered by Emily, Corvo's daughter and a deposed empress, sculpted more for ranged combat and the manipulation of foes, eventually unlocking the powerful Domino ability that chains the fates of enemies together. Setting one on fire burns them all; an executioner can be linked to his victim, and lose his own head. Take that idea and have some cruel fun with it, especially if you then throw a doppelgänger of yourself, created with another of Emily's abilities, into the mix.

It's playing as Emily that sees *Dishonored 2* come into its own. There's only one path, no matter which character you choose, and entire ideas and ways of playing are dreamed up for one level only, then discarded to make way for something else. While Corvo can still ghost his way through as if he was never there, there's something about his gruff delivery and heavy sword-fighting that doesn't sit right. Emily, able to stand off, observe, and affect happenings from a distance, is a better fit for the game.

Instead of differing missions, *Dishonored 2* offers differing ways to play. Stealth may be better rewarded, and feel like the "correct" approach, but slashing your way through is just as valid. You just might not get such an exultant ending.

The rules are not left unbroken, though. An entire sequence that runs on clockwork could be a metaphor for the game itself, as guards follow their patrol paths and you pull levers to transform it, if it weren't for the way NPCs surprise you. Save a civilian from a guard, and he might go running for more soldiers, rather than spare a word of thanks.

The new city of Karnaca deserves praise. The product of an on-team architect at Arkane, it offers a sunnier alternative to the smoky Dunwall, and shows off the abilities of the Void Engine, powered by idTech.

Dishonored 2 is imaginative and beguiling in a landscape that features the *Hitman* DLC-fest. It's different and fresh, a perfect foil to the man-with-gun homogeneity of modern games, and deserves to be celebrated as one of gaming's true originals. –IAN EVENDEN

VERDICT 9

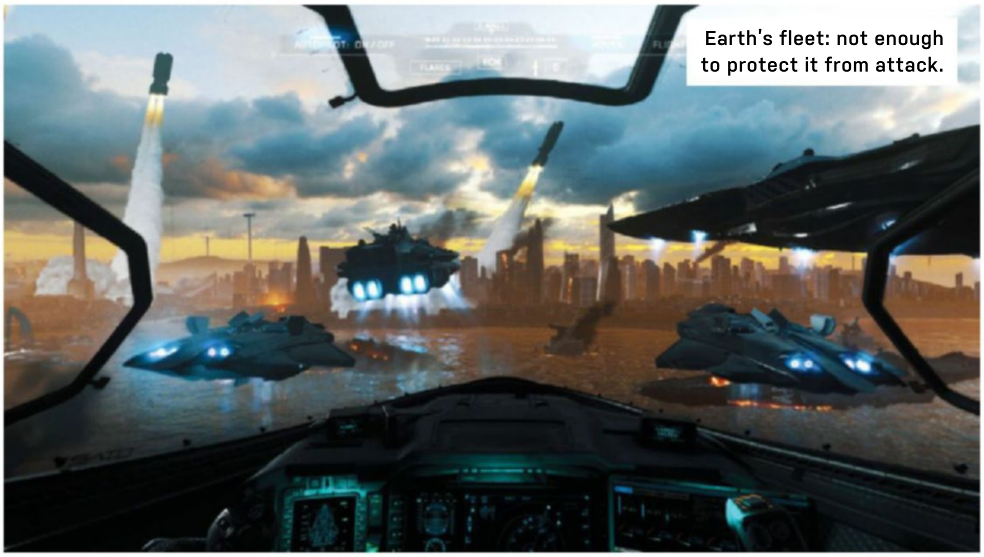
Dishonored 2

HONOR Compelling; original and distinctive.

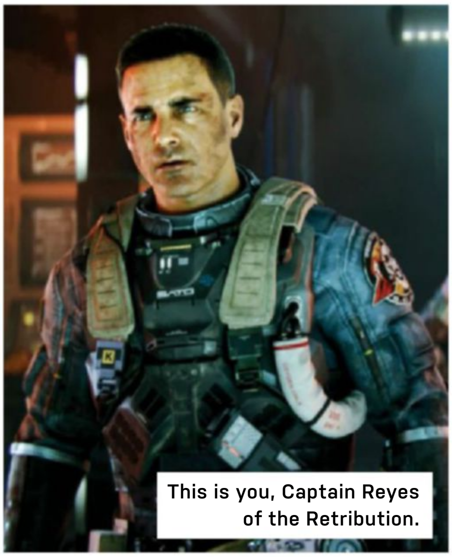
HODOR Story exposition can be slow; path forward not always clear.

RECOMMENDED SPECS Intel Core i7-4770/ AMD FX-8350; 16GB RAM; Nvidia GTX 1060 6GB/AMD Radeon RX 480 8GB; 60GB space.

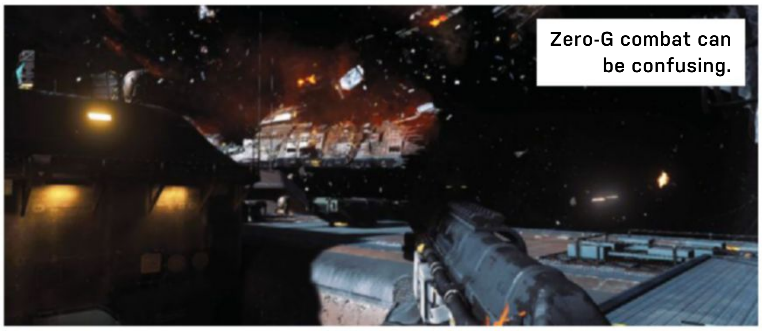
$60, http://dishonored.bethesda.net, ESRB: M



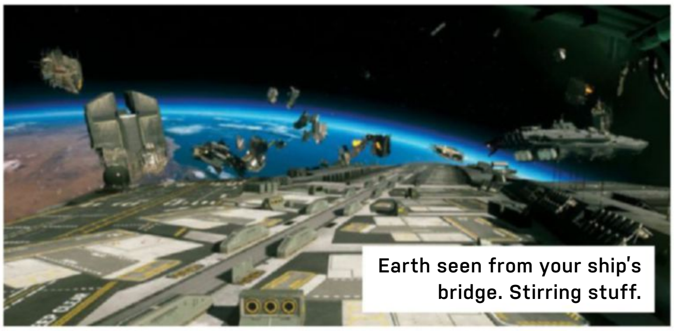
Earth's fleet: not enough to protect it from attack.



This is you, Captain Reyes of the Retribution.



Zero-G combat can be confusing.



Earth seen from your ship's bridge. Stirring stuff.

Call of Duty: Infinite Warfare

To infinity… and that's it

FOR A WHILE NOW, the campaigns in *Call of Duty* games have felt a little like training for the multiplayer. And with many players having decamped to *Battlefield One,* the developer needed to produce something distinct enough to tempt them back.

It has sort of succeeded. The outer space setting is certainly a contrast to *Battlefield's* European fields, but it's in single-player that Infinity Ward shows it has been paying attention to developments in other games.

Infinite Warfare shares a few ideas with previous mainline *COD* games. The story sees a commander wrestling with the dichotomy of winning his battles for the greater good versus saving the lives of his men. In a universe that would find *Black Ops'* robot limbs useful, we're fully human, with just a suit and an oxygen supply to protect us from a horrid vacuum death.

Because we're in space, we can still wall-run, however, and gravity can be switched on and off as the plot demands. One sequence sees you breach a spaceship's windows from the outside, sucking all the air out and suffocating the crew. Another, as you fly a fighter ship between asteroids, gives a glimpse of a game that might have been, taking multiple routes, and destroying targets in an order you choose.

From the beginning, with a cloud-diving insertion that reminds us of *MDK*, you're led by the nose through missions in which your AI companions wait for you to catch up, before allowing you the honour of landing the final shot, opening the door, or throwing the switch that leads to victory. There's always plenty to look at, as things explode, topple, and spin into space.

Infinity Ward has clearly been playing old PlayStation 2 games as well, as the whole setup is a little bit *Killzone,* with a lot of brown marines on gray backgrounds to deal with. Spotting the difference between a bad guy and a member of your squad would be tricky if your reticule didn't snap to the right ones to shoot when you pull the trigger.

This is handy, due to the amount of time you spend hunkered behind cover. Seeker grenades, gunship strikes, and hacking modules seem to have been designed around this restriction, allowing you to continue fighting even though your head is down. That the designers needed to make this concession is a bit of a criticism of *COD's* style of warfighting—standing in the open or jetpacking up for a higher perch gets you cut to pieces, yet that's precisely what you want to do in order to be a hero.

Your space carrier represents the best idea, allowing you to zoom around the solar system taking on challenges, but this small borrowing from *Mass Effect* can't distract from the linear nature of this shooter, even if it does show you some remarkable sights along the way. **–IAN EVENDEN**

VERDICT
7

Call of Duty: Infinite Warfare

+ LIGHTYEAR Cacophonous space shooting; nice lighting effects; imaginative battles.

− ZURG Ridiculous characters; linear.

RECOMMENDED SPECS Intel Core i3-3225 @ 3.3GHz; 8 GB RAM; nVIDIA GeForce GTX 660/AMD Radeon HD 7850; 70GB space.

$60, www.callofduty.com, ESRB: M

LAB NOTES

ALAN DEXTER, EXECUTIVE EDITOR

Windows 10 Fun

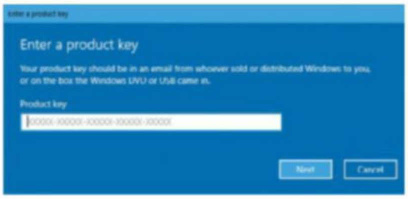
Come on Microsoft, you can do better than this!

A COUPLE OF MONTHS AGO, I mentioned that I was having problems activating Windows 10 on one of my systems after I upgraded the CPU, motherboard, RAM, and graphics card. I was tempted to install Ubuntu, but as a last ditch effort (and on the advice of one of our calmer readers), I elected to get in touch with a Microsoft support engineer first.

One option is to chat with the engineer using a messaging app, and that's the one I went for. This turned out to be a good choice, because it allowed me to check off various activation codes without having to read out the 25-digit digits over the phone. It also meant he could check a few things using a remote desktop connection, to help confirm that I wasn't trying to pull a fast one.

The guy I dealt with was calm, clear, and very helpful. And I did eventually end up with an activated copy of Windows 10, though it did take a long time due to the machine in question—a PC that can trace its origins back to a pre-built system from a now defunct system builder. Even though the engineer managed to sort me out in the end, the situation is still ridiculous.

In order to activate the machine, I had to trawl through several Windows codes, some upgrades to existing operating systems, others less obvious, until I ended up with an old Windows 7 code I had emailed myself seven years ago. When I did copy and paste this across to the engineer, he initially said that it had already been upgraded to Windows 10 (which is obvious, given that's what was running on the machine before the upgrade), but once he'd taken control of my machine, and sorted a few keys out, I was good to go. So am I now back on Microsoft's side? Not quite. While I understand that Microsoft has to defend itself against pirates, having a system that tracks upgrades properly would have saved me many hours of effort. There was only ever one copy of Win 10 on that machine, and while it looks like it has the ability to keep track of that, the dots aren't lining up yet.



Enter a product key

Your product key should be in an email from whoever sold or distributed Windows to you, or on the box the Windows DVD or USB came in.

Product key

XXXXX-XXXXX-XXXXX-XXXXX-XXXXX

Activation is more hassle than it should be.

ZAK STOREY

Reviews Editor

When the Source 340 Elite chassis came in, I fell in love. I fell in love with its style, its class, and its elegant and sophisticated build features. And it got me thinking that perhaps it's time I upgraded, and stepped away from the Manta. The fans were already annoying the crap out of me, but more frustrating was the screen situation. Allow me to clarify: At work, I have a 1080p iMac for what we call corporate work (I access the company servers on it), and then I have a custom-built ITX machine constructed from spares and leftover hardware for everything else. Connected to that are two 27-inch 1440p 144Hz TN panels, which are beautifully smooth, and a joy to work on. At home, on the other hand, I have a 28-inch 4K TN beast—however, it's limited to 60Hz.

So, the concept of 4K gaming has started to grate on me. Although it's entirely possible, the fact that I'm working on a 144Hz screen and gaming on a 60Hz panel in my spare time just isn't making any sense. So I'm going to rotate the 4K out in favor of a 165Hz IPS variant instead. To do this, I'm going to combine the Source 340 with a whole new setup. I'll be swapping out the cooling, the motherboard, and the storage, whilst also taking the opportunity to upgrade up to two GTX 1080s combined with an HB SLI bridge to really cement my spare-time experience. I'll let you know how it goes.

Editors' Picks:
Digital Discoveries

Tuan Nguyen, editor-in-chief, and Jarred Walton, senior editor, reveal their latest tech loves

SAMSUNG MULTIXPRESS M5370LX

I'm crazy about technology. Being in this job, I get to play with all the latest gadgets, often before they hit the market. I've seen a lot of really cool things over the years, but one of the craziest I've experienced recently is being able to watch Netflix or stream my Plex media off my NAS on to… wait for it… my printer.

Yes, the printer I have can browse the web, using Google Chrome, and watch movies with a native Plex app.

I've been playing with Samsung's M5370LX, which is a multifunction laser printer that's meant for handling office duties. It's got an automatic document feeder to handle scanning jobs, and is very fast at spitting out full sheets of text and images at 55 pages per minute. But then it's got a huge 10.1-inch touchscreen on it that allows me to install apps. So I installed Chrome and Plex. I tried watching *House of Cards* from Netflix, and it's great. And Plex lets me stream my media from my NAS. The printer handles both with no issues.

It's utterly absurd I know, but there's something so cool about being able to watch a movie on your printer. Despite this being so cool, there's one thing left I need to try: installing the original *Doom.* Why? Because people have gotten *Doom* to run on their graphing calculators, and I'll be damned if I can't play *Doom* on my laser printer.
$3,699,
www.samsung.com

RAZER ORNATA CHROMA

I'm a massive fan of mechanical keyboards. They feel good to type on and have a visceral effect on my cold fingers. So imagine my surprise when Razer sent me its membrane Ornata Chroma keyboard, pitching that it would feel just as good as the expensive mechanicals I've been using. No way, I said.

I was wrong. I've been using the Ornata Chroma in place of my Das Keyboard 4 with MX Blue switches for several weeks, and I'm addicted. But the Ornata isn't a complete membrane keyboard, it has what Razer calls mecha-membrane. The switches have a metal nub above the membrane switch that clicks as you press down on the keys. An obvious solution, but the effect is profound.

Describing the feel is difficult. It's not quite like the Cherry MX switches I'm used to, and it's not quite like a membrane either. Think of the key travel as a clear mechanical snap, with the softer landing of a membrane.

At first, using the Ornata Chroma felt strange. I wasn't sure I was going to like it. When I switched back to my Cherry MX Blue keyboard, however, I missed the Ornata's feel. That's when I knew it had me hooked. If you can, find one at a local store and try it out for yourself. I think Razer has a winner.
$99, www.razerzone.com

GEEK TESTED & APPROVED

Wacom Bamboo Slate

AS JOURNALISTS working for any publication, we get called to a wide variety of events and meetings, both in our own offices and across the globe. And at those events, we write. A lot. Whether it's on a laptop, a notebook, a tablet, or the ever-reliant pen and paper, we write. Notes, interviews, product reviews, concepts, ideas, drawings, brainstorms, insults, and nonchalant doodles of breasts, we write.

The problem? Space. Unlike bulky and energy-hungry tablets and laptops, a pen and paper is unbeatable in its ease of use. Combine that with a relatively small footprint and vast versatility, and it's the obvious choice. The only downside? Transferring those thoughts to a digital format to be shared across platforms. Wacom believes it's come up with a solution in the form of the Bamboo Slate. It's a neat little device, coming in either A4 or A5 sizes, and you can sync it to your smartphone or PC via Bluetooth, press a button, and immediately save anything that you've written down using the included pen.

It's an exceptionally niche product, but it works rather well. Whether you want to take the equivalent of a print to digital screenshot, or transcribe your writing down automatically, the Slate has you covered. It's not infallible, and it is quite pricey for what it actually is, but being able to convert your designs straight from pen to pixel can be exceptionally useful for any budding creative professional. **–ZS**
$130, www.wacom.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Battlefield Frame Rates
> Ad Blocking
> Temperature Tests

Overclocking Options

I have an Asus ROG Maximus VIII Hero Alpha running a Core i7-6700K chip with XMP settings, and I'm trying to follow your overclocking article *[Dec 2016 issue]*. It says, "Input a slightly higher number multiplier." I've looked all over AI Tweaker under "Advanced Mode," and can't see this "42" number, or where I can increase it to "44." **–Kerry Gifford**

REVIEWS EDITOR ZAK STOREY RESPONDS: In AI Tweaker, look for the section that says "CPU Core Ratio," and change it to "Sync All Cores." Once selected, four more options appear below, three grayed out. The first says "1-Core Ratio Limit," and in the box next to it, it should say "Auto." This is where you can set the multiplier. Type "44" into the box, and it overrides the Auto, and sets the multiplier as 44. Then it's just a case of working your way up, and changing the Core Voltage at the bottom of this screen, as stated in the article, and you'll be on to a winner.

A quick heads up: I like to switch off "Asus MultiCore Enhancement" when I overclock. It's great for additional stock performance, but at higher overclocks, it adds an element of instability, and tends to lead to (confusingly) lower overall performance, at least in our testing.

Battling Hardware

After I read your October 2016 $699 VR PC issue, I started wondering how well the build would perform when playing *Battlefield 4* on high settings on a non-VR setup. Even though the FX-8320E has mediocre single-core performance, I've heard of tweaks where one can get *BF4* to use up to six cores instead of one. So, is the RX 480 powerful enough to run *BF4* on moderate/high at decent frame rates? **–Charlie**

REVIEWS EDITOR ZAK STOREY RESPONDS: We've dug into our archives and corroborated our results with colleagues, and the RX 480 should be powerful enough to run *Battlefield 4* on Ultra comfortably. Sadly, we only have *Battlefield Hardline* on our results tables, at an average frame rate of about 60fps at 1080p, with everything ramped up. That said, we predominantly benchmark on Intel Core i7 processors as well, to maintain an even playing field, free of bottlenecks. So, I got in touch with our contact at AMD, just to triple-check, and he assures us that you should be able to get around 80fps in *BF4* on Ultra with the 8320E and an RX 480, based on the fact he's getting about 70fps with an RX 470 and an FX 8300.

Hope that helps with your decision making.

Stealth Blocking

I have a question relating to ad blockers. It seems there's a war between companies, like Facebook, and consumers who don't want to see obtrusive ads. But why aren't there any browser add-ons that load the site as normal, but don't display the obnoxious ads? It could use the "reasonable ads" criteria to encourage advertisers to keep their ads unobtrusive, without hurting the websites in the process.

One might say this only moves the problem, except the advertisers, not the site owners, are the ones losing money for trying to display video ads and pop-ups. Do you know any practical reason why it wouldn't work? **–Brendon Matusch**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: There's no obvious reason why this wouldn't work, but I don't think it's really the answer we need, although it's worth covering a couple of things first. One of the reasons for the popularity of ad blockers on mobile is that they save bandwidth, and your idea wouldn't help that at all. On our PCs, that's less of a problem, although not everyone has unlimited connections, so it could be an issue there, too. And if you're downloading potentially malevolent adverts, they could still be a problem.

There's a bigger issue here: advertisers would believe their message is getting out there, but it wouldn't be, so they'd drop advertising, which would lead to websites not being able to generate enough revenue to exist, and the standard web model would come crashing down. While shifting the problems to the advertisers and getting them to play fairly is a noble concept, at the moment the war seems to be getting worse, if anything, with advertisers trying to find ways to get around all ad blockers—something that

↘ submit your questions to: comments@maximumpc.com we feel isn't going to end well, either.

While a future where we have to pay to visit every website isn't out of the question, it wouldn't be my preferred choice. I feel the answer lies in whitelisting certain advertisers, but that only works if we buy from them, not just let them display their adverts.

Cool Dream PC

I love when someone takes the time to document how they build their computers. It's a personal side that's rarely revealed. You put all the components together, showed some benchmarks, but missed the point of liquid cooling: Where are your temperatures? With all that work, tell us your lowest and highest temps at idle and at full load! Inquiring minds want to know.

–Peter Romano

REVIEWS EDITOR ZAK STOREY RESPONDS: I love a well-documented build, too. The amount of time I've spent pondering other people's build logs for inspiration is ridiculous. In fact, I did a lot of research on the In Win 909 Owner's Club before starting that build.

As far as temperatures go, we didn't have enough space in the mag to include them in the traditional formats. At idle, the CPU loop, while overclocked to 4.2GHz, was running at 36 C, which ramped up to 82 C under full load. Which is hot, but we also ran it passively cooled to a degree, so I was impressed all the same.

The GPU loop featuring the triple rad was far more impressive: At idle it settled in at 22 C, with the first card spiking up to 47 C under load, while the second card stayed at about 42 C. Pretty cool, I think you'll agree.

We've already got big plans for next year's Dream Machine, looking at a custom acrylic case, a more cooling-friendly design, and using copper tubing, but we'll keep that between us.

Overprotection

With so many apps available for "protection from the Internet," what is enough, not-enough, or overkill? I use Norton Security Deluxe, SUPERAntiSpyware Professional, Malwarebytes Anti-Malware Home (Premium), Malwarebytes Anti-Exploit Premium, CCleaner Professional, Secunia PSI, and FileHippo App Manager.

–Jerry Franco, Jr.

SENIOR EDITOR JARRED WALTON RESPONDS: I'm of the mindset that less is more, and don't use anything more than the built-in Microsoft stuff (Defender, Security Essentials, Firewall), and I keep Malwarebytes (free version) handy to scan for when things are off. I also know enough to do a lot of my own scanning and troubleshooting, though, and I don't usually visit sites or download stuff that would cause problems. I surf with Chrome, and have uBlock Origin extension installed, and that has kept me safe.

I haven't had a virus in a decade or more. But my kids aren't old enough to be doing sketchy stuff on the PCs, and I limit what they're allowed to do. I have relatives whose teenagers seem to get a new infection every month! Malwarebytes remains one of the best solutions for helping remove garbage programs, though.

The reason I've stuck with Microsoft is that, for one, its stuff is free and integrated into the OS. Secondly, MS has a vested interest in not making your PC run slow. Defender isn't perfect, but every time I've encountered a system with McAfee, Norton, or AVG installed, I swear those big security suites overtax everything but the most powerful PCs. On a midrange system, they can cause serious slowdowns. One thing you don't want to do is have two of the same type of program running—two antivirus scanners, for instance. They'll sometimes fight with each other, and if one such app can slow down your PC, two doing redundant checking is a sure-fire way to a poor user experience.

Straight In

I have been running an OCZ RevoDrive 3 for years, and have been very happy with its performance. But it has to boot the BIOS, then the SSD BIOS, then boot the OS. It takes much longer to boot to Windows than I'd like. Do new PCIe SSDs behave the same? Or do they boot right into Windows? **–Sid Phillips**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: In many ways, the RevoDrive 3 was ahead of its time, and one of the downsides of that was a prolonged boot process. The good news is that modern motherboards are far quicker at getting you in your operating system. The bad news is that you'll need a new mobo to get the most out of newer SSDs—M.2 and NVMe drives that are natively supported by new motherboards don't have any additional boot stages versus a SATA drive. Of course, this means you've probably got a complete new system build on your hands. If you're looking at a new build, rest assured that modern drives can boot faster—20 seconds from a cold boot to being in Windows 10—otherwise, you could just get used to putting your PC to sleep, rather than turning it off. ⏻

[NOW ONLINE]

THE BEST RGB LED LIGHTING KIT

If there's one single feature PC hardware companies have beaten to a bloody pulp by now, it's RGB lighting. Some purists argue that it's an unnecessary gimmick, but others can't help but be drawn to the appeal of having a 24/7 party on their desktop. Lucky for them, there's also plenty of LED lighting options to bring the party to the PC, too.

Lighting up the interior of a PC is nothing new. Cold cathode light tubes, basic LED strips, and LED fans have been used to light up builds for well over a decade now. But with more and more users showing off the inside of their clean builds, it was only a matter of time before RGB hit the interior lighting space. We checked out a ton of available LED kits to find the best way for you to light up your build, and have picked our favorites. You can read the full story online at http://bit.ly/2fUR9N5.

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THE BUILDS

BUDGET

MIDRANGE

INGREDIENTS

PART			PRICE
Case	Phanteks Enthoo Evolv ITX	**NEW**	$60
PSU	EVGA 450B Bronze	**NEW**	$46
Mobo	Gigabyte GA-H110N	**NEW**	$75
CPU	Intel Core i5-6500		$205
GPU	Zotac GeForce GTX 1060 Mini 3GB		$185
RAM	8GB (2x 4GB) Crucial Ballistix Sport LT		$47
SSD	240GB SanDisk Z410 2.5-inch SSD	**NEW**	$64
HDD	1TB Hitachi 7,200rpm 3.5-inch SATA		$40
OS	Ubuntu Desktop Linux 16.04 LTS 64-bit		$16

Approximate Price: $738

THAT'S ONE HECK OF A SHAKE-UP to the budget build, huh? Four new components and a saving of $62, even including a slightly pricier chassis. The Thermaltake Core V1 wasn't cutting it for us anymore, and we wanted a system that was a little easier to piece together than inside the claustrophobic confines of the Core. The Phanteks Enthoo Evolv ITX has a plethora of cooling options, room for large cards, and a compartmentalized design to improve ease of access. We also stepped down from the SuperNOVA 550W PSU in favor of EVGA's 450B. At most, our system only draws 250W from the wall, so this still gives us plenty of headroom. On top of that, we also went from the ASRock H170M ITX mobo to the Gigabyte GA-H110N. Still supporting DDR4, and even including a hidden M.2 slot for future PCIe storage upgrades, it's the perfect entry-level board for anyone looking to build their own system with future-proofing in mind.

INGREDIENTS

PART			PRICE
Case	NZXT S340 Elite	**NEW**	$100
PSU	Corsair RM650x 650W 80 Plus Gold	**NEW**	$99
Mobo	Gigabyte GA-Z170XP-SLI	**NEW**	$110
CPU	Intel Core i5-6600K		$250
Cooler	Corsair H100i v2		$103
GPU	EVGA GeForce GTX 1070 SC Gaming ACX 3.0	**NEW**	$400
RAM	16GB (2x 8GB) G.Skill NS Series DDR4-2400		$80
SSD	250GB Samsung 850 EVO M.2		$95
HDD	Western Digital Black Series 1TB 7,200rpm		$70
OS	Windows 10 Home 64-bit OEM		$100

Approximate Price: $1,407

ANOTHER HUGE CHANGE to the midrange this issue. We're swapping out our NZXT Manta for the S340 Elite. NZXT's hit the nail on the head with this ATX chassis, with the perfect balance of airflow and style. It's a real treat, fantastic to build in, and allows us to expand our support from ITX motherboards all the way up to ATX. We also decided to drop EVGA's SuperNOVA G2 650W 80 Plus Gold for something a little more classy. Corsair's RM650X PSU comes with a lovely set of flat black cables, allowing you to make a tidy build with ease, and if you want, you can always sleeve these later, or buy a pre-braided kit. On top of that, we picked up a Gigabyte GA-Z170XP-SLI mobo, and swapped out the Gigabyte Windforce GTX 1070 for an EVGA SC Gaming ACX. We know there have been problems with memory on some of EVGA's cards, but these have been resolved, and all cards out of the factory now come with the correct BIOS to ensure it doesn't happen.

TURBO

WE FINALLY DROPPED the Intel 1.2TB PCIe SSD. It wasn't quite quick enough for what we wanted to do anymore, and the form factor and additional PCIe slot were enough to put us off and head over to the Samsung side of flash memory. Samsung's 1TB 960 Pro is around $200 cheaper, allowing us to drop a bit of cash elsewhere, and deal with the price hikes we're seeing across the board. We also changed out the Asus X99-A II for MSI's X99A SLI Plus. Although slightly more expensive, the A II has been bumped back up to $250, making the SLI Plus the better value option. MSI's UEFI BIOS does need a bit of tweaking, but it's a solid performer, and comes with plenty of expandability, including SLI support, alongside M.2, and a strong rear I/O solution. We swapped out the single 4TB Western Digital Black drive for two 2TB variants, too. Although not as cost-effective as the single 4TB, we can set these up as a mirrored RAID array, ensuring we've got extra redundancy for our work and mission-critical files. Memory prices are continuing to creep up, so we've dropped the 32GB Corsair Vengeance LPX 2666 quad-channel kit for its slightly slower little brother, and even that is pricier than the $168 we reported last issue. Other changes remain subtle. We saw the price of the case and the graphics card increase, and have done our best to balance those, swapping out the EVGA GPU for an MSI iteration instead, yet we've still managed an overall saving of $140.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART			PRICE
Case	Phanteks Enthoo Evolv ATX		$170
PSU	EVGA SuperNOVA G2 750W		$110
Mobo	MSI X99A SLI Plus	**NEW**	$230
CPU	Intel Core i7-6800K		$450
Cooler	Corsair H100i v2		$103
GPU	MSI GeForce GTX 1080 ARMOR 8GB OC	**NEW**	$600
RAM	32GB (4x 8GB) Corsair Vengeance LPX DDR4-2400	**NEW**	$180
SSD	1TB Samsung 960 Pro M.2 NVMe SSD	**NEW**	$630
HDD	2x 2TB WD Black 7,200rpm 3.5-inch SATA	**NEW**	$242
OS	Windows 10 Home 64-bit OEM		$100

Approximate Price: $2,815

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